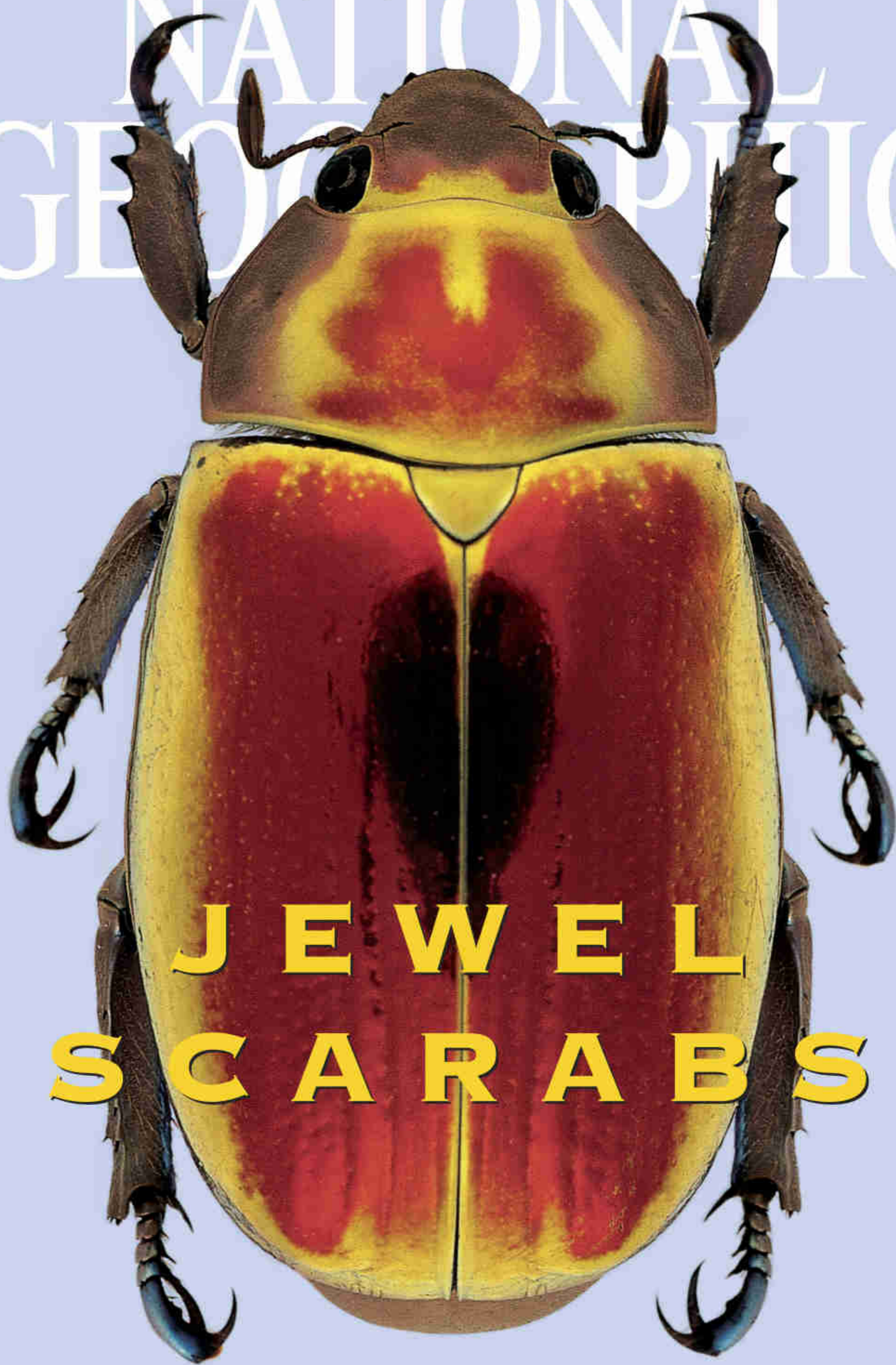


# NATIONAL GEOGRAPHIC



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**In the Shadow of the Andes** A Personal Journey 2

**A Mars Never Dreamed Of** 30 Plus: Map Supplement

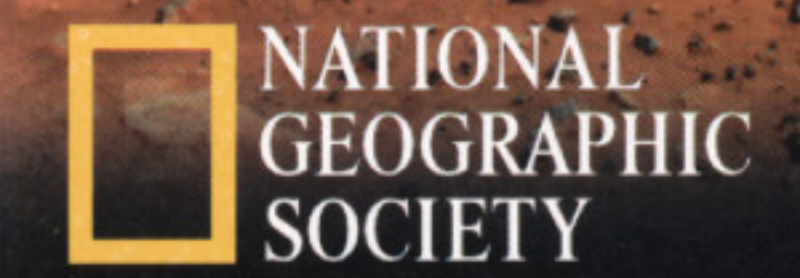
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# Mars Revealed

## A New Look at Forces That Shape the Desert Planet

Produced by National Geographic Maps for National Geographic Magazine



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NATIONAL GEOGRAPHIC MAGAZINE  
ALLEN CARROLL, CHIEF CARTOGRAPHER  
Washington, D.C., February 2001

**M**ysterious Mars has begun to yield its secrets. Images from Mariner and Viking orbiters had by the mid-1970s swept away myths of canals and crop fields. The views from space showed a dusty, barren planet with huge geologic features, most of them little changed in the past billion years. New close-in looks offer startling clues that wind and possibly water and lava are still changing the face of Mars.

**VIEW FROM PATHFINDER**  
Touching down in July 1997 in the Archaean highlands, the Pathfinder lander photographed dusty, rock-strewn wilderness. Scientists had chosen the site for its variety of floodborne material. The first Mars lander since 1976, Pathfinder transmitted data for almost three months.

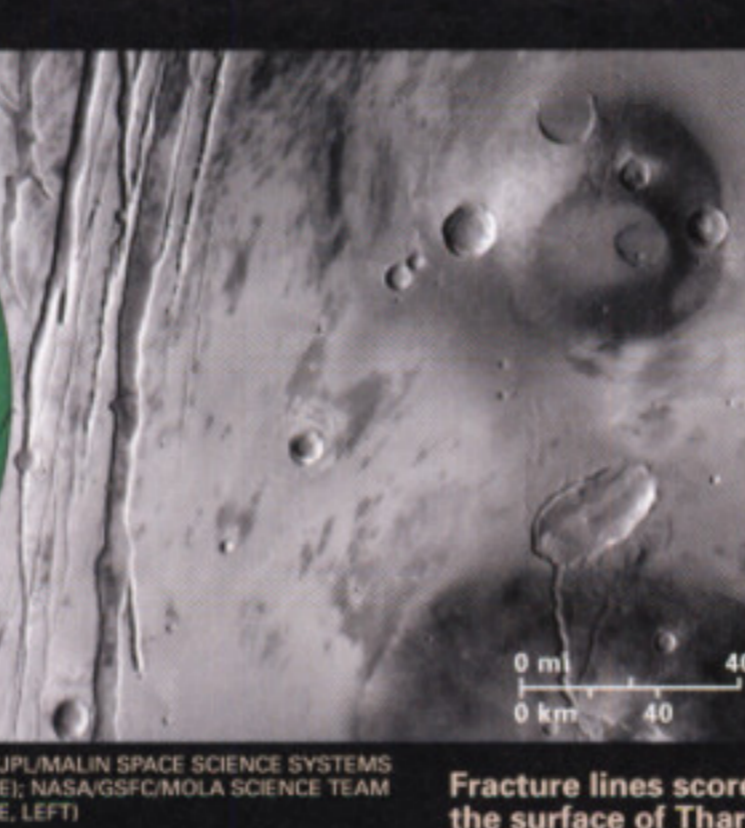
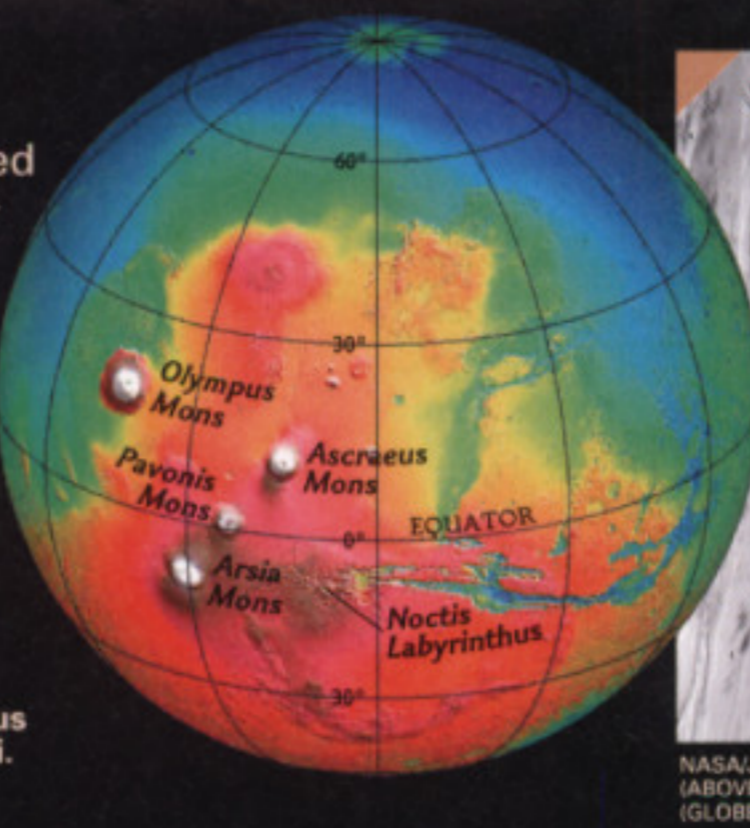
**THARISIS RISE**  
Dominant volcanic region on Mars, the 4,000-mile-wide Tharsis rise resulted from a massive accumulation of volcanic material. Enormous shield volcanoes formed along its crest and flank, their calderas each greater than 30 miles across. Because there are no shifting crustal plates on Mars, the volcanoes remain stationary above their magma sources. The combined lava flows cover an area larger than Russia. Some scientists believe that the region is still volcanically active.

Some 13 miles high and 350 miles across, Olympus Mons dwarfs the giant shield volcanoes of Hawaii.

**Olympus Mons**  
13.2 miles (21.3 km) above datum or Martian "sea level"

Mount Loa, Hawaii  
5.5 mi (8.9 km) above ocean floor

Lava flows from Arsia Mons traveled hundreds of miles.

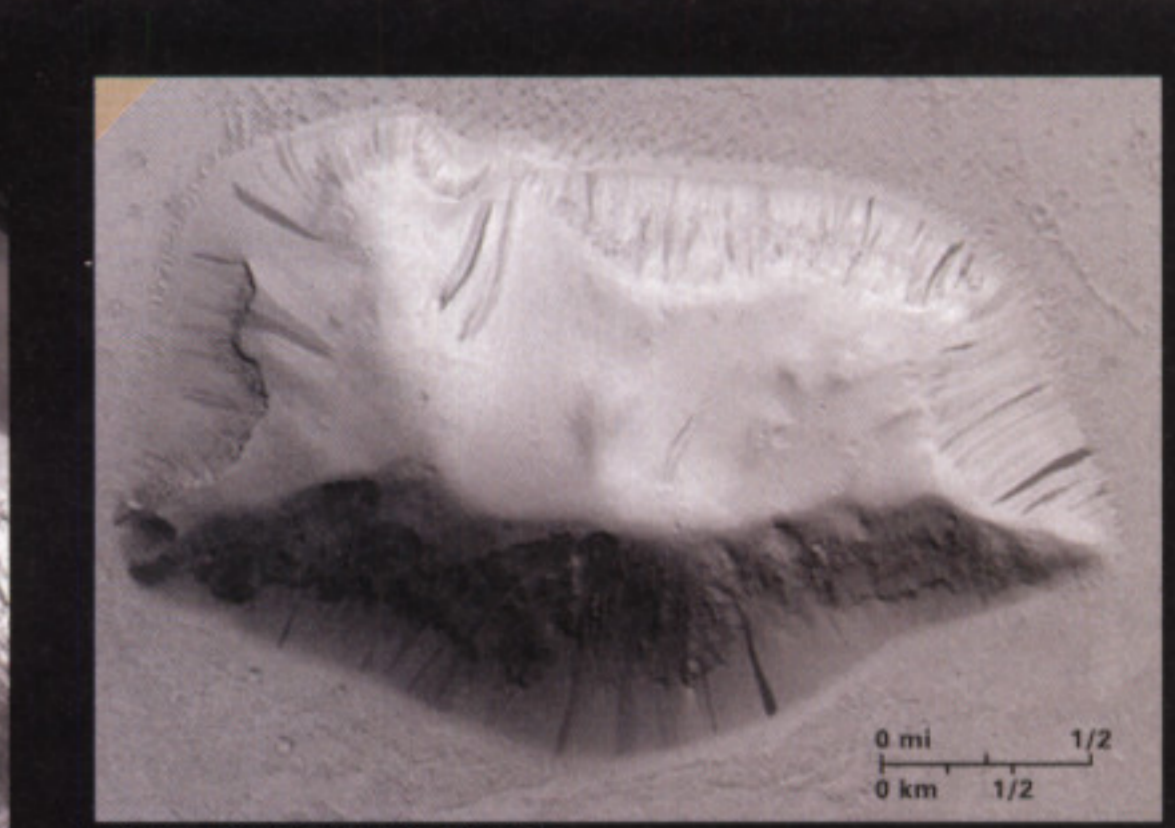


Fracture lines score the surface of Tharsis rise near two volcanoes. The network of cracks, possibly caused by the weight of the volcanic material, covers almost a third of the planet. The fractures may have piped groundwater that carved the canyons surrounding Tharsis rise.

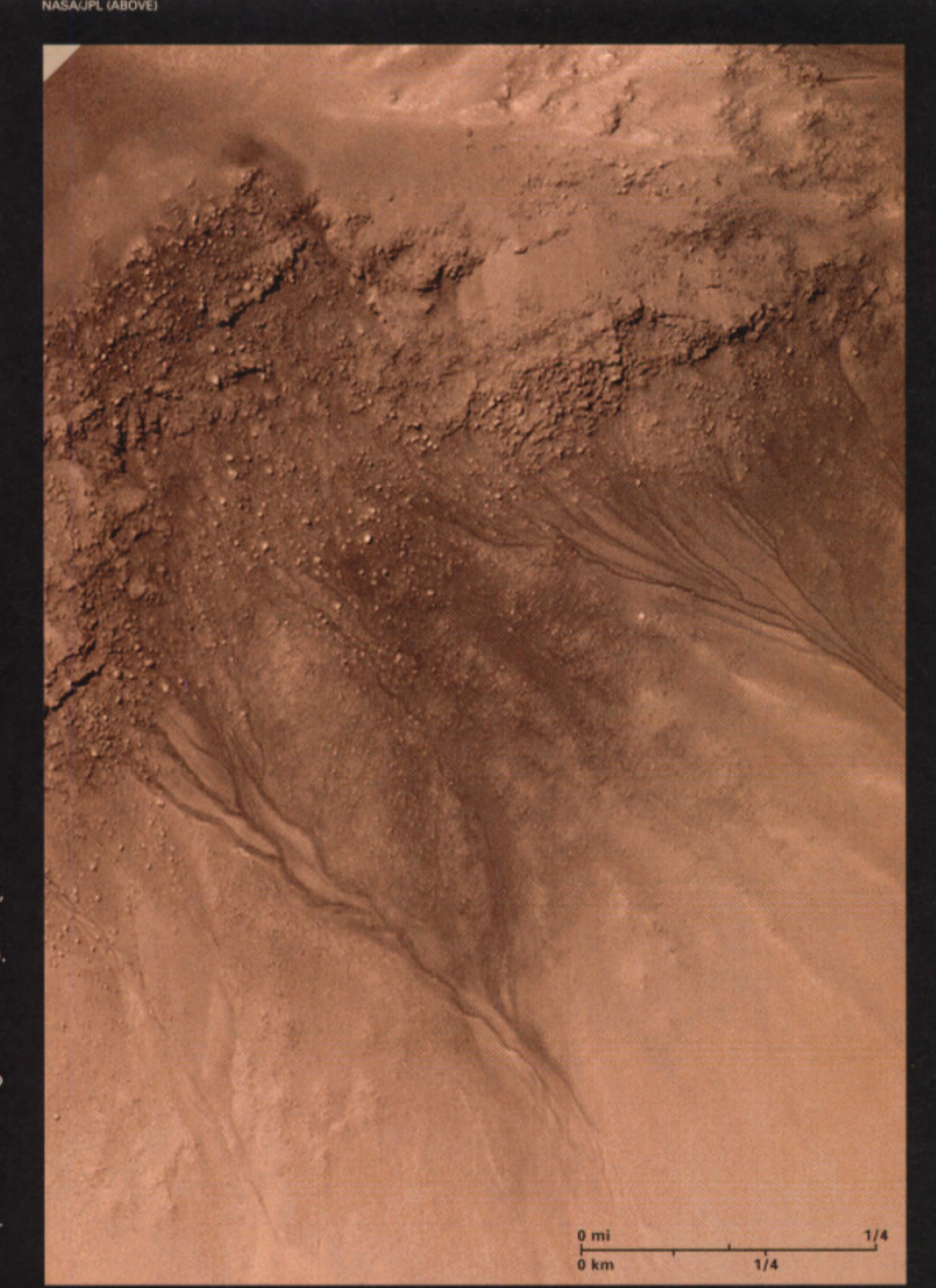
**ACTIVE LANDSCAPES**  
Orbiting Mars 12 times a day, Mars Global Surveyor provides unprecedented close-up views of a terrain being reshaped by powerful forces. With image resolution up to a hundred times greater than Viking orbiters, Surveyor's camera, able to detect objects five feet across, reveals a surface at the mercy of wind, ice, and possibly water.



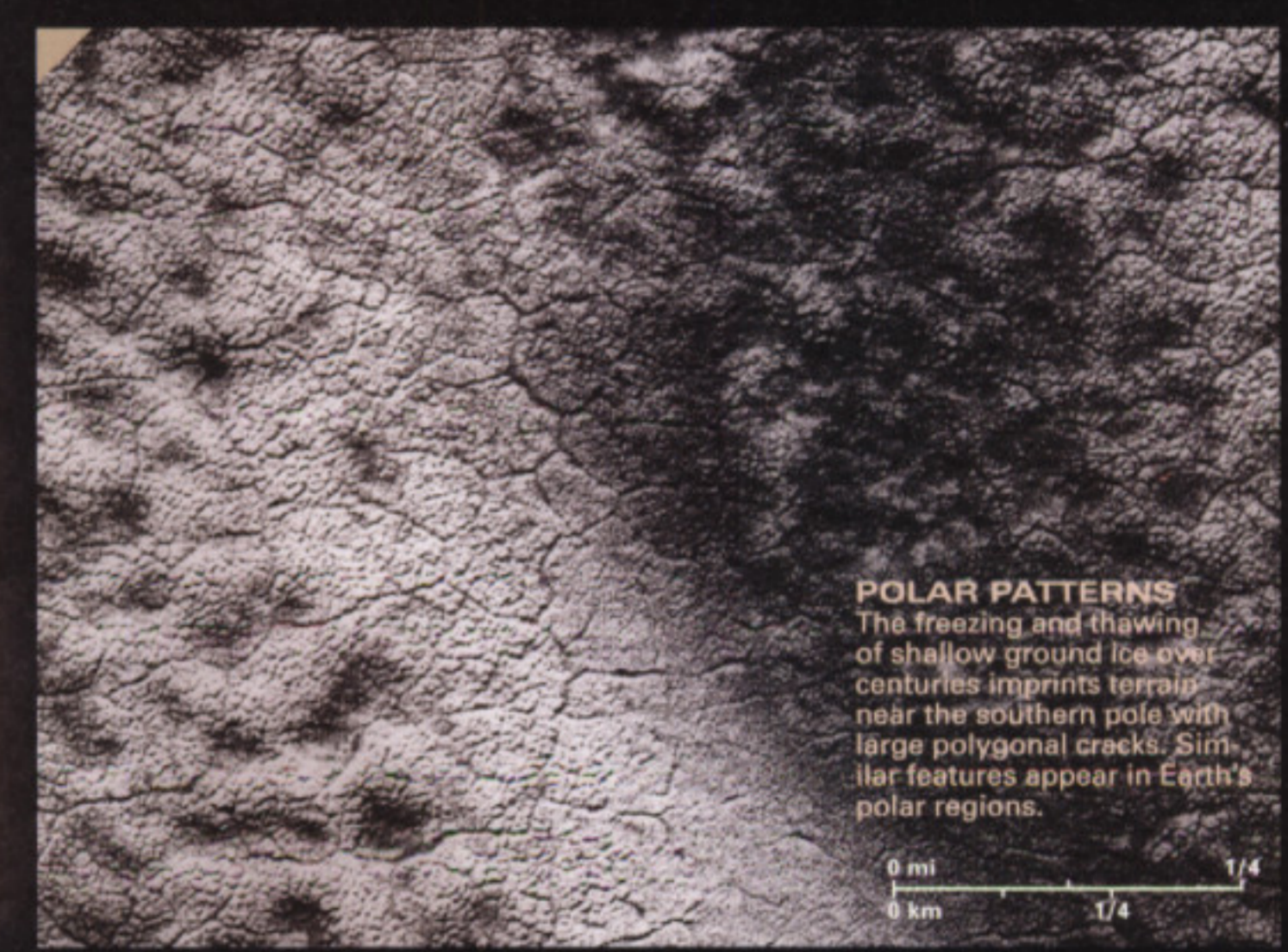
**BLOWING DUST**  
Ferocious dust storms periodically cover the entire surface of Mars. The Viking 2 orbiter in 1977 photographed the makings of a huge storm as a giant plume of dust (right) rose across the Claritas Fossae highlands. Big storms primarily occur when Mars comes closest to the sun. Additional solar heating causes updrafts that lift dust into the atmosphere. Dust veils the planet in cloud for months at a time. Regionally, winds gather sand in craters, valleys, and other traps to form dune fields. A high-resolution image shows marbling crescent dunes (left) inside Nilí Patara caldera.



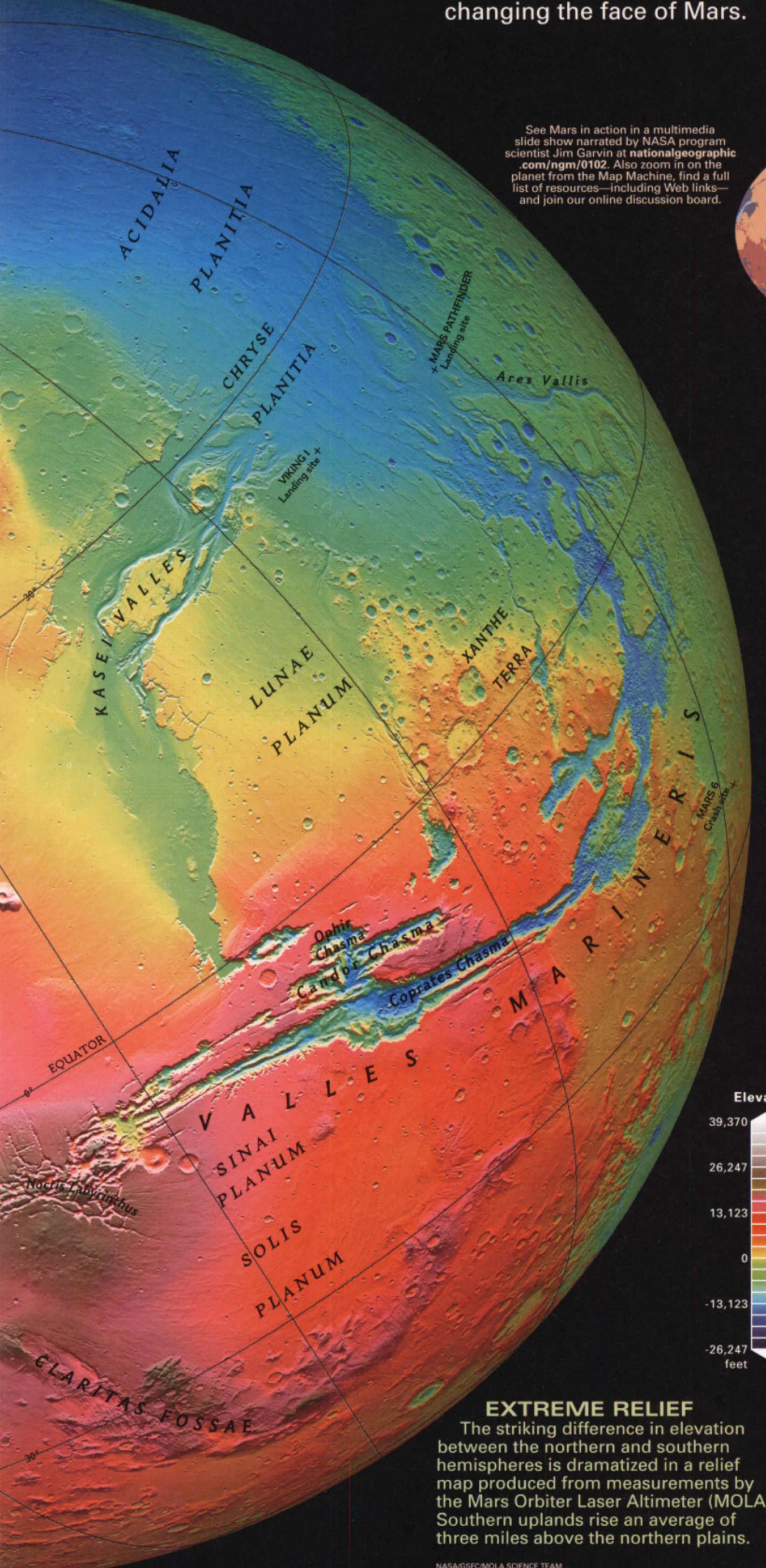
**LANDSLIDES**  
Avalanche tracks of rock and sediment streak the sides of a butte in Elysium Planitia. Darker lines indicate newer slides. On the high-resolution image (above), boulders appear as bulges on the ground.



**FLOWING WATER**  
Images of gullies etched on the walls of craters and cliffs pose the possibility that liquid water may still breach the surface of Mars. Discovered at some 120 sites, seepage channels appear mostly in the coldest latitudes on shadowed, pole-facing slopes, such as on a cliff face in Noachis Terra (right). Scientists wonder whether liquid water, having collected at shallow depths behind an ice plug, may burst forth under pressure to send a slurry of rock, ice, and water racing down a rock face. The lack of meteorite scars and lava flows on these eroded surfaces indicates that the seepage channels formed during the recent geologic past.

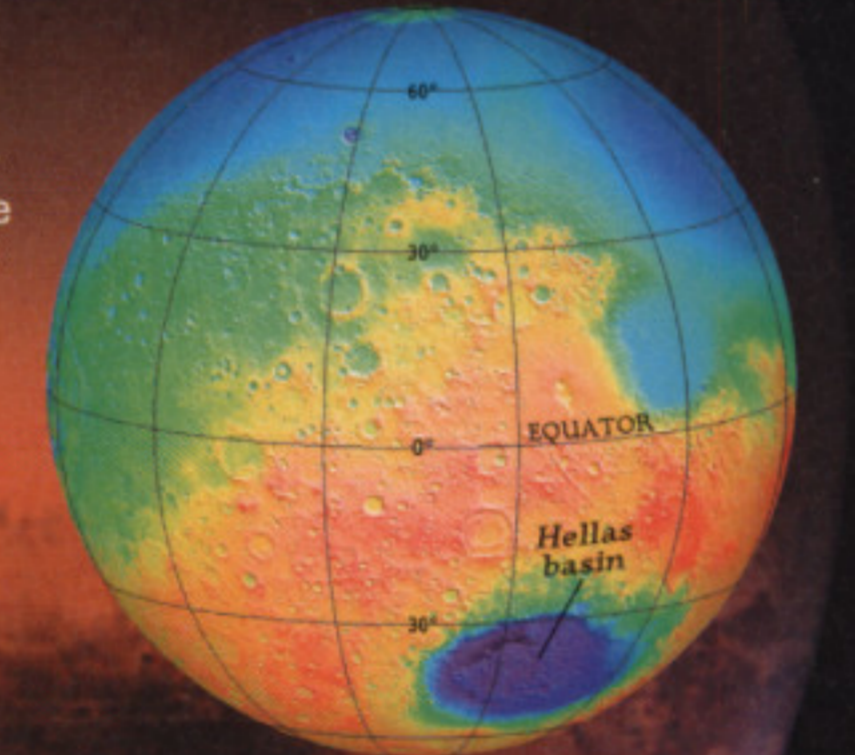


**POLAR PATTERNS**  
The freezing and thawing of shallow ground levels near the southern pole with large polygonal cracks (left) and the lack of meteorite scars and lava flows on these eroded surfaces indicates that the seepage channels formed during the recent geologic past.



**SHOWING ITS AGE**  
A prolonged meteorite bombardment during the first billion years of Mars's history left much of the surface pitted with craters. The battered surface remains largely unaltered in the southern hemisphere. By contrast, the northern hemisphere features a younger, smoother coat of material that together with erosion has erased most of the craters.

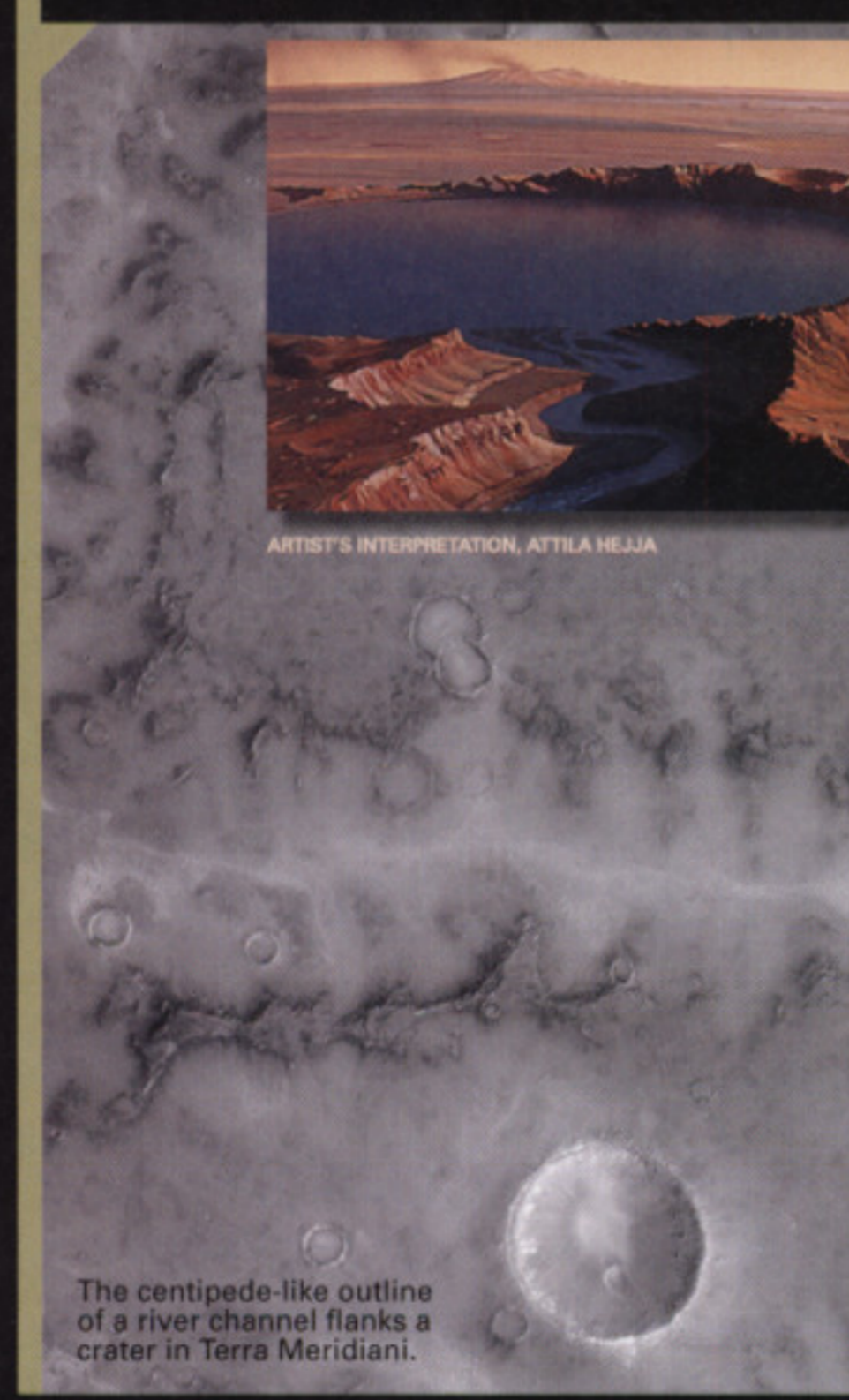
**HELLAS BASIN**  
When a meteorite perhaps as large as a hundred miles in diameter crashed into Mars four billion years ago, the force of the impact recontoured much of the southern hemisphere. The collision punched a hole in the surface 1,300 miles across and 5 miles deep. A MOLA relief map (right) shows the circular Hellas basin as the lowest spot on Mars. The fallout of debris, enough to deposit a mile-thick layer across the continental United States, stretched 2,500 miles from the basin's center.



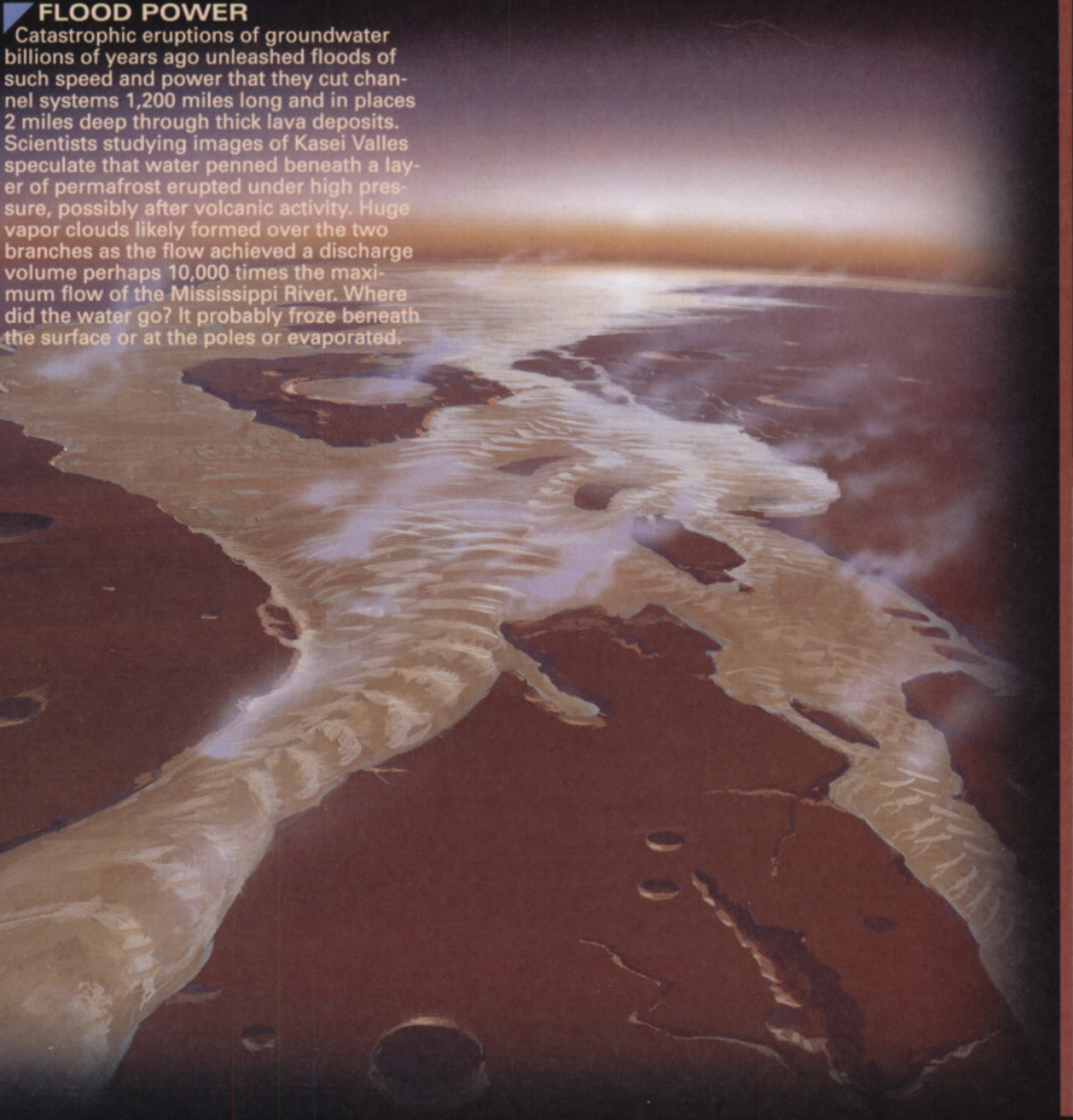
Water-scoured rocks mark the Dao Vallis channel (below, center) on the eastern margin of Hellas basin.



**EARTHLY RIVERS**  
The outlines of small riverbeds, like one shown in a high-resolution image from Terra Meridiani (below), provide strong evidence that water once flowed slowly—not just in convulsive floods—across the Martian surface. The detection of river valleys supports theories that in its early stages Mars had a significantly warmer climate. Under today's conditions, liquid water would quickly freeze or evaporate. Some researchers guess that the water came from underground aquifers. Scientists hope to find traces of ancient shorelines at sites where water may have pooled, such as Gusev crater (art inset).



**FLOOD POWER**  
Catastrophic eruptions of groundwater billions of years ago unleashed floods of such speed and power that they cut channel systems 1,200 miles long and in places 2 miles deep through thick lava deposits. Scientists studying images of Kasei Valles speculate that water perched beneath a layer of permafrost erupted under high pressure, possibly after volcanic activity. Huge vapor clouds likely formed over the two branches as the flow achieved a discharge volume perhaps 10,000 times the maximum flow of the Mississippi River. Where did the water go? It probably froze beneath the surface or at the poles or evaporated.



**CANYON MYSTERIES**  
Valles Marineris, the steep-walled canyon system that runs for 2,500 miles along the equator, displays large-scale geologic processes, many of them puzzling. Faulting and erosion likely created the huge main corridors that in places are 400 miles wide and up to 4 miles deep. Side canyons show evidence of massive landslides (right). Scientists debate whether seeping groundwater undermined the rock strata or whether sublimation of ground ice—its change from a solid to a gas—loosened the material. Layering (below) suggests that some surfaces may be made of sedimentary rock, formed on the bottoms of lakes or seas.



An oblique view of a landslide scar in Candor Chasma, created from Viking orbiter images, reveals a large apron of debris sloughed from its walls.

**Astronomer Johannes Kepler** describes elliptical orbit of Mars.  
**Christiaan Huygens's** sketch of Syrtis Major records the first recognizable feature on Mars.  
**Giovanni Virginio Schiaparelli** detects a network of "canals" system as proof of irrigation ditches on Mars.  
**William Herschel** observes seasonal change at the poles.  
**Tacian creator Edgar Rice Burroughs** publishes a series of books set on Mars.

**NAMING THE RED PLANET**  
Its red color and loopy, seemingly erratic path through the night sky led ancients to link Mars with war and chaos. Babylonians named it Nergal for the god of death. Greeks called it Ares for their war god, which for the Romans became Mars.

**Orson Welles's** radio broadcast of War of the Worlds parades listeners, who fear a Martian invasion.  
**Carbon dioxide** identified by Gerard Peller Kupar as component in Mars's atmosphere.

**Ray Bradbury's Martian Chronicles** describes the first attempt of Earthlings to conquer and colonize Mars.  
**Cold War Hollywood** turns Martians into scary monsters and femmes fatales.

**My Favorite Martian** introduces to television a sweet, nonthreatening alien.  
**Sputnik 29 and 30** fail in attempted Mars flyby. Sputnik 31, a lander, also fails.  
**Soviet Union's** first Mars effort ends with failed launches of two spacecraft.

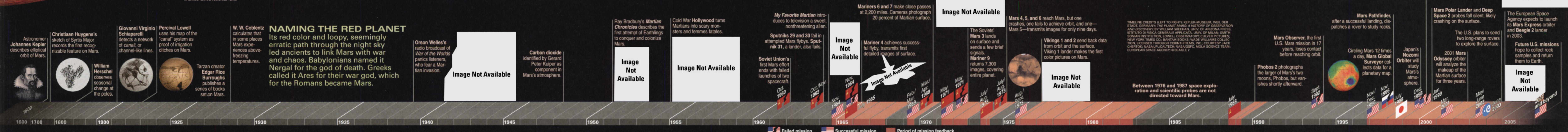
**Mariners 6 and 7** make close passes at 2,200 miles. Cameras photograph 20 percent of Martian surface.  
**Mariner 4** achieves successful flyby, transmits first detailed images of surface.  
**Mariner 9** returns 7,300 images, covering entire planet.

**Mars Observer**, the first U.S. Mars mission in 17 years, loses contact before reaching orbit.  
**Vikings 1 and 2** send back data from orbit and the surface. Viking 1 lander makes the first color pictures on Mars.  
**Phobos 2** photographs the larger of Mars's two moons, Phobos, but vanishes shortly afterward.

**Mars Pathfinder**, after a successful landing, dispatches a rover to study rocks.  
**Mars Polar Lander and Deep Space 2** probes fall silent, likely crashing on the surface.  
**2001 Mars Odyssey** orbiter will analyze the makeup of the Martian surface for three years.

**The U.S.** plans to send two long-range rovers to explore the surface.  
**Future U.S. missions** hope to collect rock samples and return them to Earth.

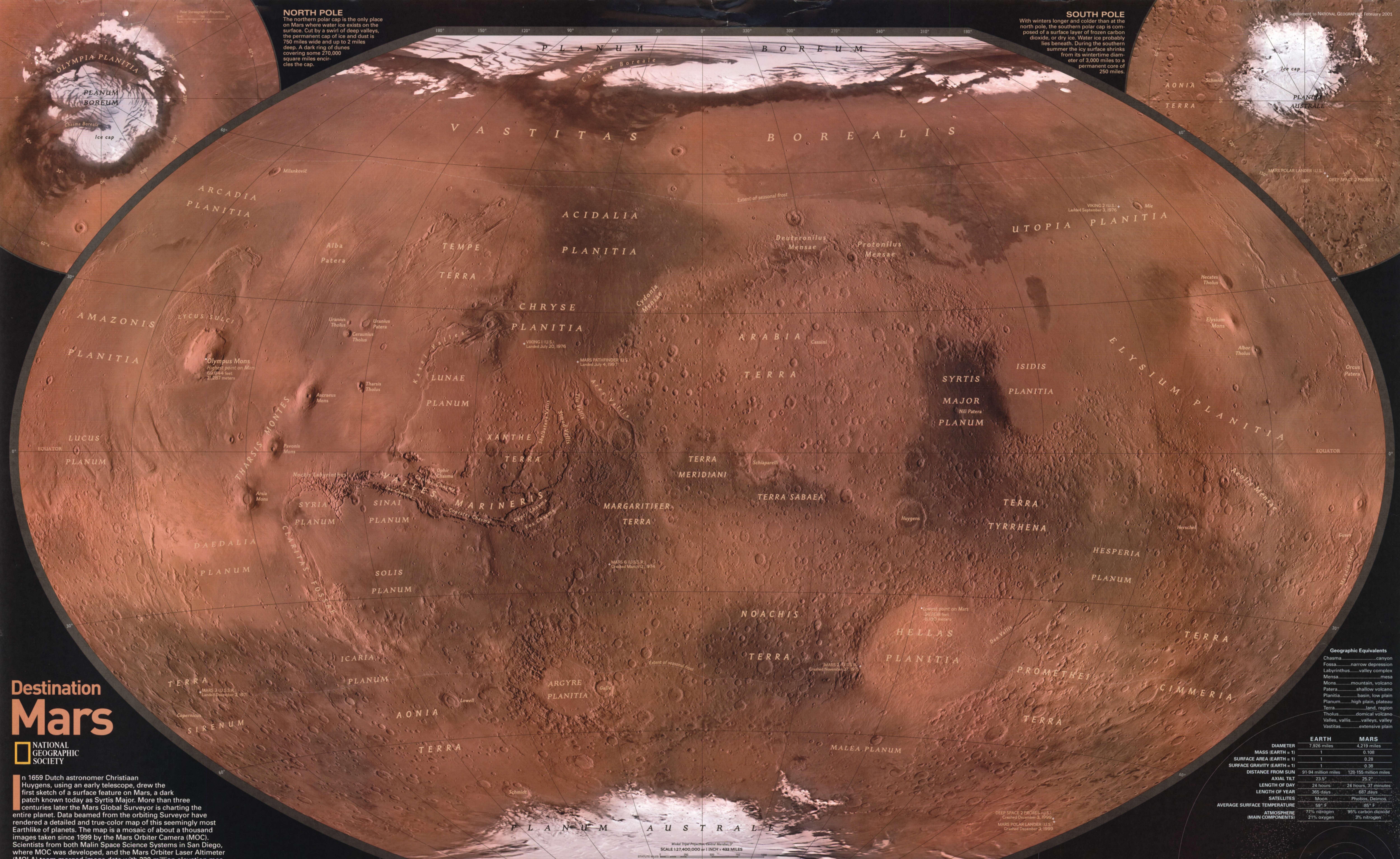
**The European Space Agency** expects to launch its Mars Express orbiter and Beagle 2 lander in 2003.





**NORTH POLE**  
 The northern polar cap is the only place on Mars where water ice exists on the surface. Cut by a swirl of deep valleys, the permanent cap of ice and dust is 750 miles wide and up to 2 miles deep. A dark ring of dunes covering some 270,000 square miles encircles the cap.

**SOUTH POLE**  
 With winters longer and colder than at the north pole, the southern polar cap is composed of a surface layer of frozen carbon dioxide, or dry ice. Water ice probably lies beneath. During the southern summer the icy surface shrinks from its wintertime diameter of 3,000 miles to a permanent core of 250 miles.



# Destination Mars

**NATIONAL GEOGRAPHIC SOCIETY**

In 1659 Dutch astronomer Christiaan Huygens, using an early telescope, drew the first sketch of a surface feature on Mars, a dark patch known today as Syrtis Major. More than three centuries later the Mars Global Surveyor is charting the entire planet. Data beamed from the orbiting Surveyor have rendered a detailed and true-color map of this seemingly most Earthlike of planets. The map is a mosaic of about a thousand images taken since 1999 by the Mars Orbiter Camera (MOC). Scientists from both Malin Space Science Systems in San Diego, where MOC was developed, and the Mars Orbiter Laser Altimeter (MOLA) team merged image data with 330 million elevation measurements. The resulting map, a NATIONAL GEOGRAPHIC exclusive, provides the sharpest view yet of Mars and its spectacular terrain.

Mars image (above) created by Michael Caplinger and Michael Malin, MSSS; data from NASA/JPL Mars Global Surveyor mission, MOC and MOLA science teams. Images of Neptune, Uranus, Saturn, Jupiter, and Mars (right), NASA/JPL/Caltech; Earth image, NASA/GSFC; Mercury image, USGS; sun image, SOHO/ESA/NASA

**Geographic Equivalents**

- Chasma.....canyon
- Fossa.....narrow depression
- Labyrinthus.....valley complex
- Mensa.....mesa
- Mons.....mountain, volcano
- Patera.....shallow volcano
- Planitia.....basin, low plain
- Planum.....high plain, plateau
- Terra.....land, region
- Tholus.....domical volcano
- Valles, vallis.....valleys, valley
- Vastitas.....extensive plain

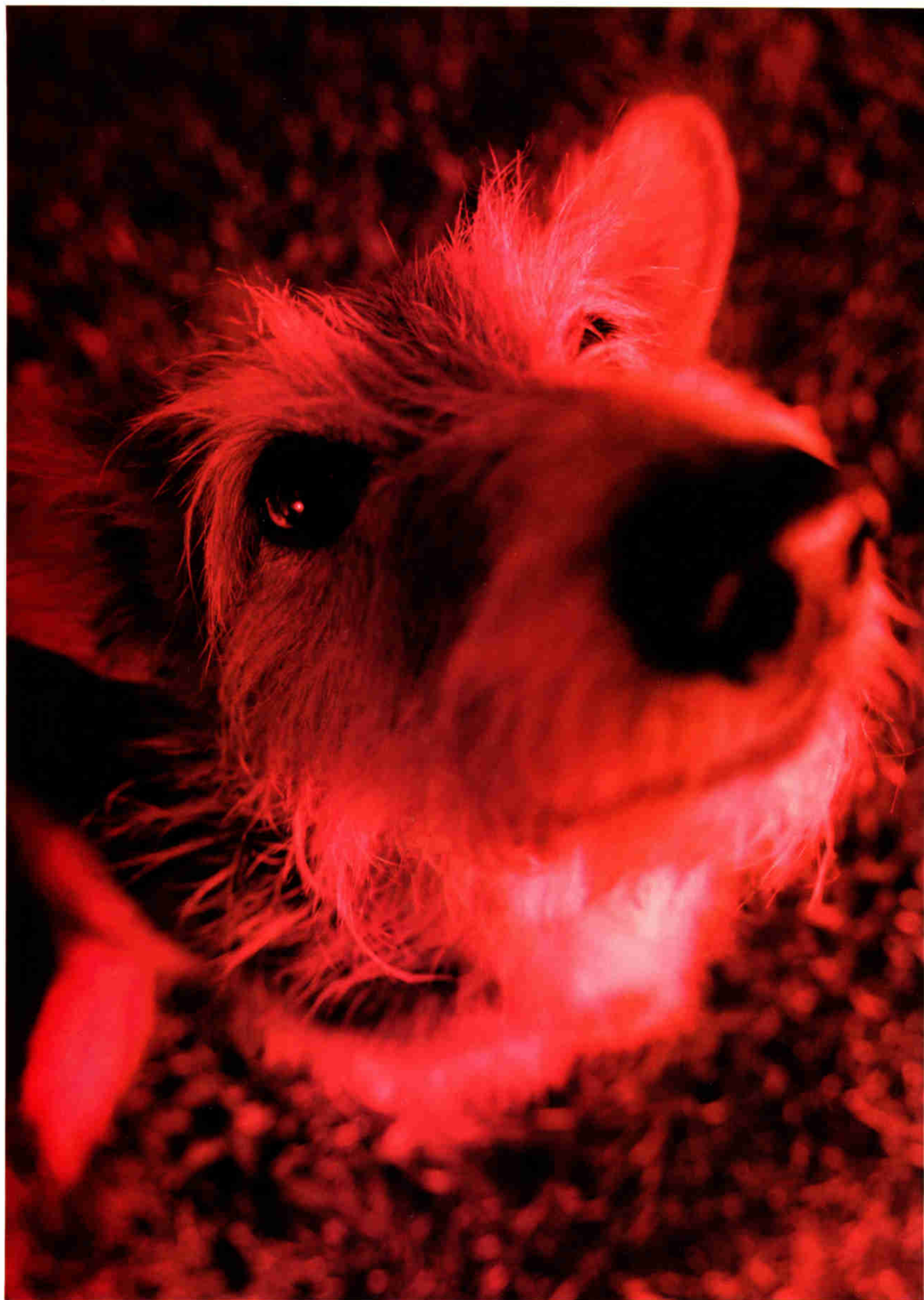
	EARTH	MARS
DIAMETER	7,926 miles	4,219 miles
MASS (EARTH = 1)	1	0.108
SURFACE AREA (EARTH = 1)	1	0.28
SURFACE GRAVITY (EARTH = 1)	1	0.38
DISTANCE FROM SUN	91-94 million miles	128-155 million miles
AXIAL TILT	23.5°	25.2°
LENGTH OF DAY	24 hours	24 hours, 37 minutes
LENGTH OF YEAR	365 days	687 days
SATELLITES	Moon	Phobos, Deimos
AVERAGE SURFACE TEMPERATURE	59° F	35° F
ATMOSPHERE (MAIN COMPONENTS)	77% nitrogen	95% carbon dioxide
	21% oxygen	3% nitrogen

Winkel Tripel Projection, Central Meridian 0°  
 SCALE 1:27,400,000 or 1 INCH = 433 MILES

Longitude numbers increase to the west in accordance with astronomical convention, but some scientists now prefer longitude increasing to the east (eastward longitude shown in parentheses).

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Valued at \$150 by collectors, *Chrysina aurigans*—a denizen of the Costa Rican forest—also dazzles scientists.

PHOTOGRAPH BY  
 DAVID HAWKS

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VALLEYS EAST OF THE HELLAS PLAINS: NASA, JPL, AND MSSS

## Are we Martians?

Is there life on Mars? Was there ever life on Mars? Did a collision of an asteroid and the primordial Mars blow tiny precursors of present-day life-forms to Earth billions of years ago? (You may recall that the Tagish Lake meteorite, which landed in British Columbia in January 2000, carried organic molecules from the time of the creation of the solar system.) The questions seem endless as each new finding raises new possibilities.

In the August 1998 issue we brought you 3-D images of the Martian surface from the Pathfinder mission. While no Martian giraffes wandered by, the landing did reignite interest in our tantalizing neighbor. This month we return with a provocative article and supplement map that provide a revealing global view of the red planet.

Years ago I worked at Kitt Peak National Observatory in Arizona and at Cerro Tololo Inter-American Observatory high in the Andes of Chile with my friend Ted Gull, an astronomer now with NASA. I knew that what looked like little smudges on our glass photographic plates showed areas of star formation. In such stellar nurseries elements created in the explosions of supernovae come together. On at least one small planet of an insignificant star in an ordinary galaxy among billions of other galaxies, those elements eventually evolved into a being that could ask a simple but profound question: Where did we come from?

*Bill Allen*



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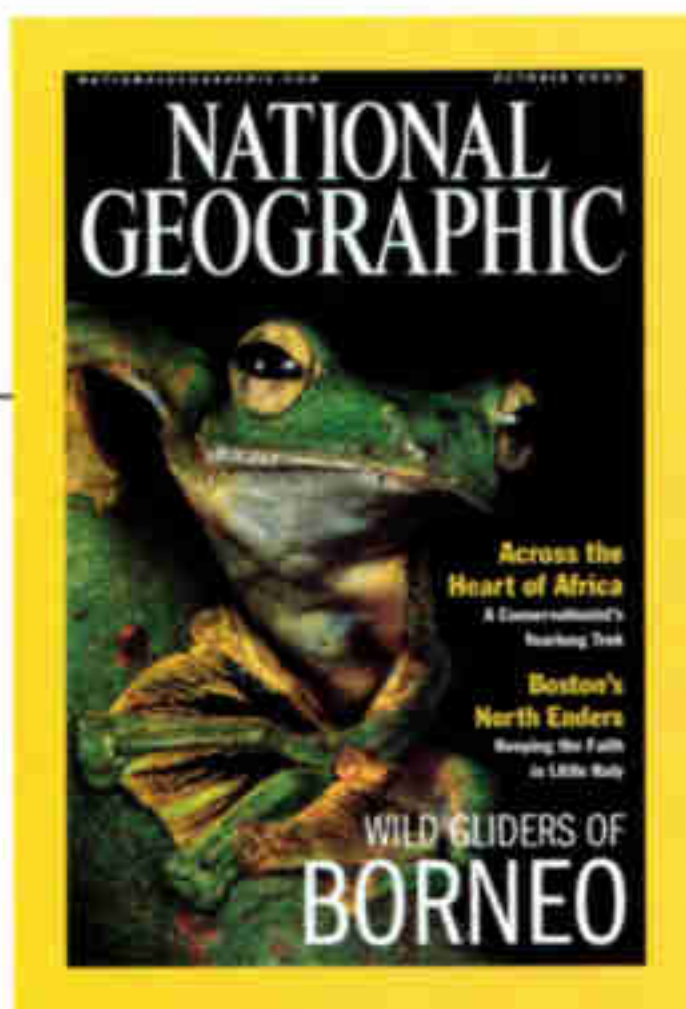
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# Forum

## October 2000

Readers of the October issue said the coverage on oceans renewed their sense of wonder and responsibility for the environment. The article on sea vents "illustrates how much we don't know about the oceans that cover more than two-thirds of our own planet," wrote one reader. "New Eyes on the Oceans' is a real wake-up call," said another.



## Oceans

The picture on page 110 says so succinctly what great catastrophes do to those most vulnerable. What a Madonna-like face, what a stricken child. I am not often moved to tears, but this photo says it all.

JOHN F. VILLESVIK  
Naalehu, Hawaii

Your October issue shows a computer-simulated path for Hurricane Gilbert in 1988 passing well south of Jamaica. In fact Gilbert scored a direct hit on Jamaica. I know because my family was vacationing there during that unforgettable experience.

STEWART SHARP  
North York, Ontario

It's clear that we just don't know how global warming will affect the planet. It seems to me that if ice caps melt enough to disrupt the Gulf Stream so that long Siberian winters quickly seize Europe, as your article states, then the freezing temperatures could help cool the North Atlantic—one of the two areas critical to ocean circulation. Any cooling could maintain the thermohaline circulation that powers the Gulf Stream. The water just has to be dense enough to sink and displace the water below it. With world oceans becoming less

saline due to the infusion of fresh water, the cold water would not have to be as saline to sink.

BENJAMIN R. JORDAN  
Kingston, Rhode Island

## Wild Gliders

What patience and ingenuity it took to get those photos! For me it brought back memories of central Sumatra. While in Rumbai I saw a lizard that might have been interesting to Tim Laman. I noticed what appeared to be a large leaf fluttering to the ground from a tree. It was a gray-brown lizard six to eight inches long. It didn't move, so I picked it up and, on impulse, tossed it into the air. It again fluttered to the ground, landing with a gentle plop. I found that it was able to flatten and greatly widen its body by spreading its rib cage. Its feet were not webbed, nor were there skin flaps between the legs or between the legs and tail. There was no gliding. It just fluttered down.

W. T. VAN RAVENSWAAY  
Bedford, Texas

Having studied tropical forests in the Americas and Borneo, I believe that the large number of gliders in Borneo is due to different forest structure rather than, as Tim Laman suggests, the



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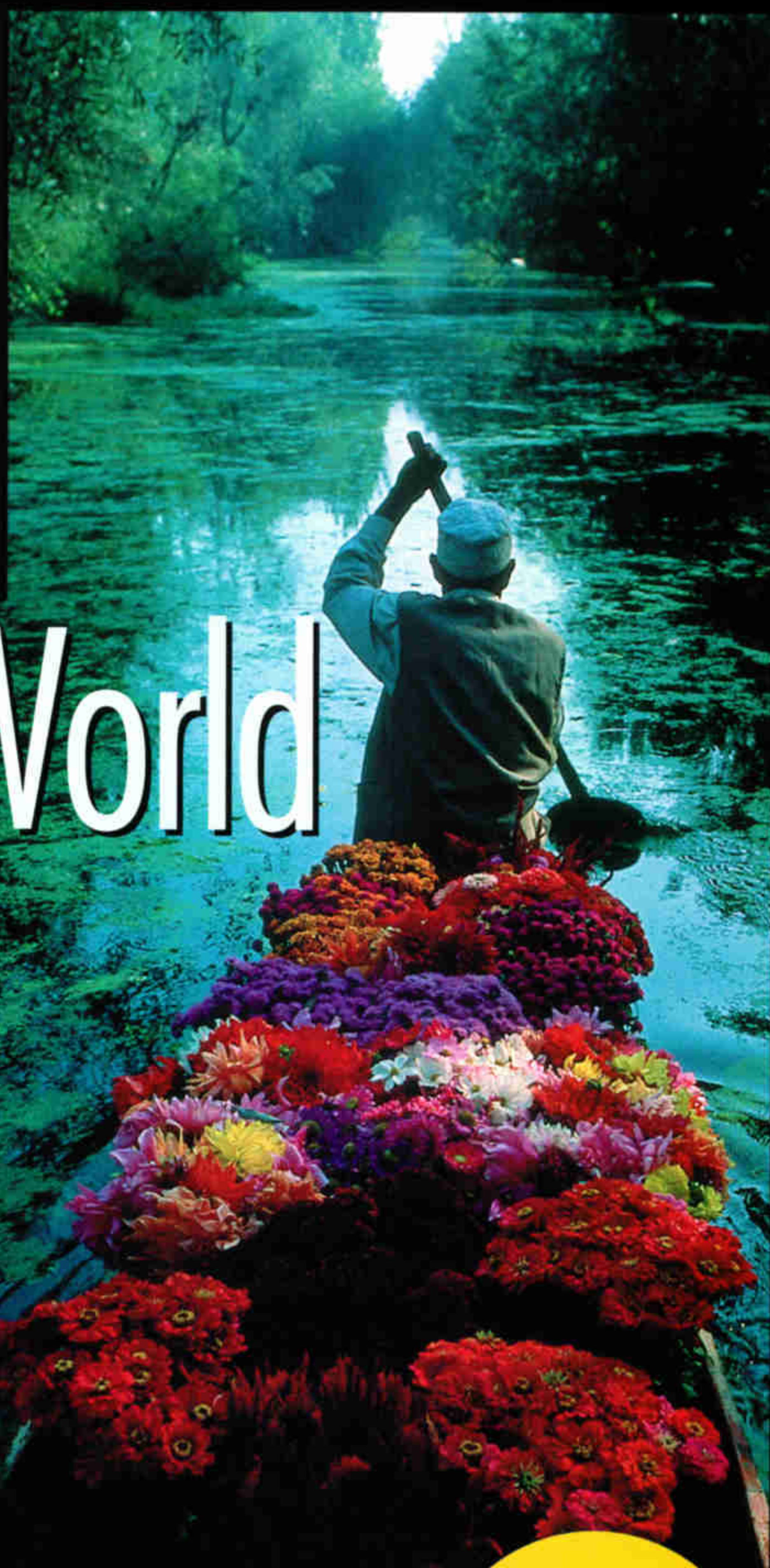
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MICHAEL NICHOLS, NGS

### Megatransect

Thank you for helping fund Michael Fay's Megatransect expedition. Not only have you invested in a great adventure for your readers, but it can be hoped that the findings will open the world's eyes to the unjust demolition of Africa's forest. We all need to wake up and realize that we are nothing without these lands. Every time an animal or tree disappears, it affects the chain

of life. Thank you, Michael Fay, for your passion and drive to make a better world.

JULIE UPSTILL  
Fort Lauderdale, Florida

Though David Quammen lacked an expert's knowledge of the terrain, he more than compensated with his ability to turn this unimaginable journey into a very tangible short story. His point of view was refreshingly realistic and succeeded in bringing me right into Africa.

JOSHUA S. FRASER  
Santa Barbara, California

To me, pictures of topless women in New Caledonia [May 2000] don't appear provocative at all. What puzzles me are pictures like the one of

the slaughtered monkey on pages 24-5. While nakedness in decent forms is nothing to worry about, the picture of this creature came to my mind hours later, in my nightmares, as a picture of cruel death.

ULLRICH GEBHARDT  
Wiesbaden, Germany

In "Megatransect" you mention previous explorers' sojourns into and across Africa. I am surprised you did not mention H. W. Tilman, a British mountaineer and explorer. He bicycled across the continent, east to west, and with his typical dry humor recounted the adventure, along with many others, in the anthology *The Seven Mountain Travel Books*.

JAMES LEHMER  
Jefferson City, Missouri

unpredictability of dipterocarp fruiting and the corresponding need of animals to be mobile. Dipterocarp forests are taller, have fewer lianas connecting trees, and have a more broken canopy than Amazonian forests. In such an environment there are both the need and the opportunity for gliding. In the dense Amazonian canopy gliding is more difficult and not necessary.

MICHAEL KESSLER  
Göttingen, Germany

Well done on the "Wild Gliders of Borneo" website [[nationalgeographic.com/ngm/0010/feature4](http://nationalgeographic.com/ngm/0010/feature4)].

#### WRITE TO FORUM

National Geographic Magazine, PO Box 98198, Washington, DC 20090-8198, or by fax to 202-828-5460, or via the Internet to [ngsforum@nationalgeographic.com](mailto:ngsforum@nationalgeographic.com). Include name, address, and daytime telephone. Letters may be edited for clarity and space.

As a teacher in Brunei with only limited time and access to the rain forests, it's great to get a virtual visit online with these amazing animals, some of which I never knew existed.

GREG MCCARTHY  
Bandar Seri Begawan, Brunei

### Sonoran Desert

At the base of Miller Peak stands Fort Huachuca, where I was stationed in the Army. Most people have never heard of it, but it has quite a place in history. As an outpost in Cochise County, it helped bring about the surrender of Geronimo. It was also the home of the famous black Buffalo Soldiers.

LEA MASTERS  
Coeburn, Virginia

In his excellent essay on flying above Arizona, Adriel Heisey states that he first thought the coyotes on a golf course (pages 48-9) in June were playing, but

when he saw behavior patterns associated with reproduction, he decided that they were mating. Actually, they were indeed romping about in play. Coyotes use actions from other social contexts—reproduction, predation, and aggression—when they play. Also, coyotes typically mate in January or February, and the females give birth 63 days later.

MARC BEKOFF  
Professor of Biology  
University of Colorado, Boulder

Your article lamented that "new construction projects keep claiming desert land." Am I to understand that construction is bad? The world was made for us, not the other way around.

JOHN JAEGER  
Irvine, California

### Fossil Trail

As a scientist (geologist), I was pleased to see your organization demonstrating professionalism



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by printing the account of errors that led to your printing the "flawed" paper on *Archaeoraptor*. However, I don't think this is nearly enough to correct the erroneous implications presented in that article. How many science teachers have used this article in their classrooms as further evidence for the evolutionary link between dinosaurs and birds?

ALAN CHEREPON  
Cedar Park, Texas

*The vast majority of paleontologists continue to subscribe to such a link on the basis of abundant other evidence.*

As a college student, I find your magazine a welcome glimpse into the outside world. Although I was disheartened to find that something I believed to be true was false, I do not begrudge your error. It is a chance to see that behind every article are real people, real emotions, and, rarely, real errors.

THOM BARRY  
Santa Fe, New Mexico

We can all understand the desire for fame and fortune as potential frailties that may taint validity. Peer review is perhaps the best tool of science for credibility. The notoriety of this event will echo for all scientists and publications, and that may be the true benefit.

RICHARD J. CARLSON  
Seattle, Washington

It must have been wrenching, stepping up to the plate to report to members on the details of the *Archaeoraptor* fossil fiasco. It hurts when the reputation sullied is steeped in such grand tradition, but your report keeps that proud heritage intact.

P. F. PINGREE  
Akron, Ohio

### Boston's North Enders

Immigrants bring with them a part of their country, and America has become a tapestry woven with their dreams and sweat. Be it the North End or Little India, these microcosms have added their own flavor to society.

SUDHA KAMATH  
Sunnyvale, California

As a national organization of Italian-American educators, we extend our deepest gratitude

## Considering the distorted view of Italian culture currently being displayed on HBO's *Sopranos*, Zwingle and Allard's reality-based article arrived like a beautiful gift.

to Erla Zwingle and William Albert Allard for their valentine to the Italians of Boston's North End. Considering the distorted view of Italian culture currently being displayed on HBO's *Sopranos*, Zwingle and Allard's reality-based article arrived like a beautiful gift. Our Roman ancestors would have said, "*Vincit veritas*—Truth conquers all things." *Mille grazie a tutti!*

BILL DAL CERRO  
Italic Studies Institute  
Floral Park, New York

### Geographica

It was with great disappointment

that I read "A Boost to Big Trees." Your report on national monument status for the entire 328,000 acres of Sequoia National Forest and the other monuments established by President Clinton indicates that you don't understand that wildlands can be managed for multiple-resource benefits while sustaining aesthetic and other values. In this particular case a multitude of opportunities to benefit both people and wildlife are being foregone.

HARRY E. HOPKINS  
Camino, California

Why did the scientists waste their time looking for a gold-colored metal for the Sacagawea dollar when Canada has had a gold-colored dollar for 15 years? The U.S. dollar and the Canadian dollar are the same diameter. I hope mine works in your coin machines. It's only worth 65 cents!

NICK ARABEY  
Toronto, Ontario

*Although they are the same size, the coins do not have the same electronic signature. Only the Sacagawea and Susan B. Anthony dollars will work in U.S. coin machines.*

### Ask Us

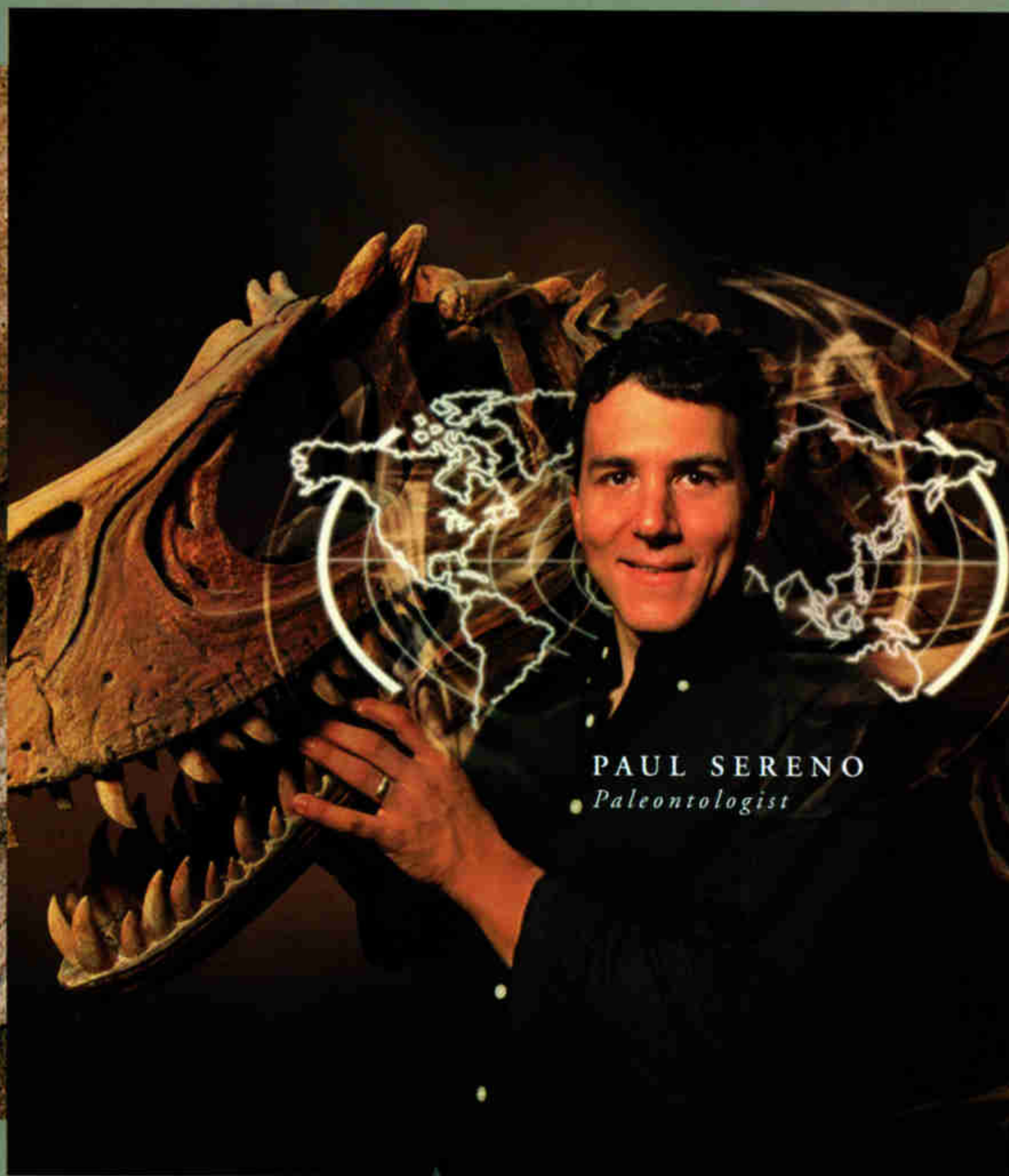
In your September issue you state that Mooselookmeguntic, Maine, is the longest one-word, unhyphenated name of a town or city in the United States. What about Kleinfeltersville, Pennsylvania?

LELA W. LOPEZ  
Myerstown, Pennsylvania

*Kleinfeltersville is the longest town name listed by the U.S. Board on Geographic Names. Mooselookmeguntic, as several readers pointed out, is a lake rather than a town or city.* □



# DID HE ALWAYS DIG DINOSAURS?



PAUL SERENO  
*Paleontologist*

In college, his goals were undecided—until he studied fossils. The rest is history. His name is Paul Sereno. He's discovered new dinosaur species on several continents. With his team, uncovered the oldest dinosaur skeleton ever found, dated to 228 million years. Is an artist as well as a scientist. Co-founded Project Exploration, which brings science to the public and inspiration to city youths. And, he's a professor at the University of Chicago. 🌱 Dr. Paul Sereno, paleontologist and National Geographic explorer-in-residence, is one of Ford Motor Company's Heroes for the Planet. A program that's part of ongoing Ford Motor Company initiatives to underwrite and support efforts that make the world a better place. 🌱 To learn more about Dr. Sereno and other Heroes for the Planet, just visit our website. You'll find fascinating information including links to his favorite web sites. Around the globe, there are amazing individuals who've dedicated their lives to our planet. You'll find them at [www.ford.com/heroes](http://www.ford.com/heroes). Stop by. The world is waiting.

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# EarthPulse

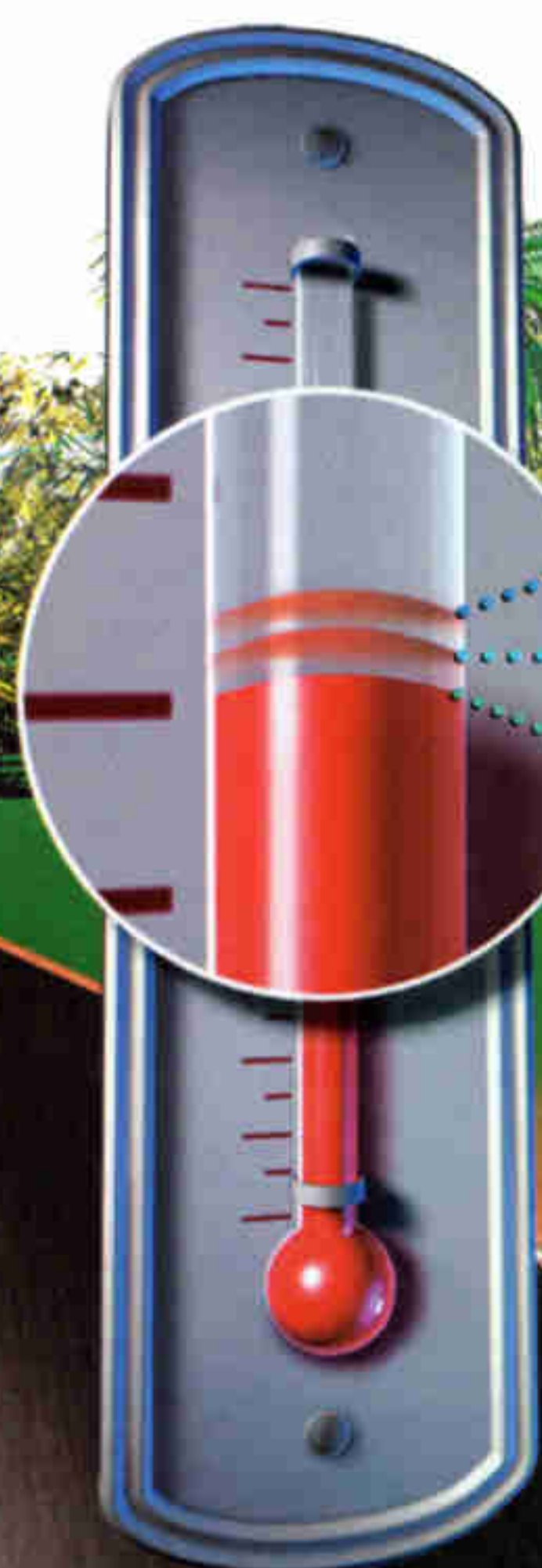
CLIMATE

## Rising Tide of Concern

*Sea levels are climbing—and people are in harm's way*

Coastal and island dwellers risk losing their homes, or even their lives, as a consequence of rising oceans. In the past century sea levels climbed an average six inches—a figure that seems small but reflects a rate of increase ten times the average over the past 2,000 years. The world is warming, causing seawater to expand and accelerating the melting of mountain glaciers. Melting polar ice sheets could eventually add to the rise.

Sea levels have fallen and risen over the millennia. At the peak of the Ice Age 20,000 years ago, average sea level was 400 feet lower. Even if the pollutants that contribute to temperature rise are reduced, the climb is expected to continue in the 21st century, hiking sea levels along with it. The consequences: flooding, erosion, tainted drinking water, displaced populations, and loss of farmland and biodiversity. How will Earth cope?



AVERAGE TEMPERATURE

62°F in 2100

58°F in 2000

57°F in 1900

20 feet by 3000?

### Worst-case Scenario

An ice sheet an average 5,000 feet thick covers 700,000 square miles of Greenland. If global warming increases over this millennium and that ice melts, sea levels would creep up to 20 feet higher, dramatically redrawing Earth's map.

### Warming and Rising

In the past century a one-degree Fahrenheit rise in global temperatures led to a six-inch sea level rise. If the Earth warms by four degrees by 2100, seas may rise another foot and a half.

AVERAGE SEA LEVEL

18.5 inches by 2100

6 inches by 2000

Sea level in 1900



**On the Waterfront** A third of the people in the world live in coastal zones. Populations concentrated in river deltas such as the Ganges in Bangladesh or the Nile in Egypt are in immediate danger of losing their homes to rising sea levels, along with some of their countries' richest farmland.

**Ground Zero** By the end of this century low-lying islands in the Caribbean could be uninhabitable, as could small coral atolls such as those in the Marshall Islands and the Maldives.

**Polar Ice** Because most Arctic ice is already floating in the Arctic Ocean, its increased melting will not raise sea levels. The danger lies in ice sheets attached to land masses like West Antarctica's coastal ice shelf. The rest of Antarctica is less vulnerable because even a rise in temperature of a few degrees would leave it below freezing and could lead to snow, which would simply add to the existing ice sheet.



■ Select regions at risk    
 ■ Sea ice    
 ■ Select islands at risk  
▨ Glaciers    
■ Land ice sheet



**Erosion**

Land-anchoring palms, mangroves, and salt marshes will drown. Louisiana's Mississippi River Delta is already losing up to 35 square miles of wetlands a year. Escalating beach erosion will eat away at property and tourism economies.

**City of the 23rd Century?**

At the current rate of increase, sea levels will be three feet higher in 200 years; coastal cities could be armored with walls and pumps. Just stabilizing U.S. coastlines in this century will cost from 100 billion to 250 billion dollars.

**As Water Draws Closer**

Without natural shoreline barriers, even moderate storms will begin to wreak the type of damage now associated with major hurricanes and their tidal surges. People with the financial and natural resources can relocate their houses, fortify shorelines, replenish beach sand. Low-lying islands face inundation and loss of fresh water as creeping sea levels infiltrate water tables.

**Get Involved**

For more information:

Climate Institute  
Washington, D.C.  
[www.climate.org](http://www.climate.org)

Intergovernmental Panel  
on Climate Change  
Geneva, Switzerland  
[www.ipcc.ch](http://www.ipcc.ch)

Find resources and a forum at  
[nationalgeographic.com/  
ngm/0102/earthpulse](http://nationalgeographic.com/ngm/0102/earthpulse).





Creating a low-emission car is not easy; creating a low-emission SUV or truck is a good deal more challenging. Yet Ford Motor Company has succeeded on both fronts. Since 1999, all Ford, Lincoln and Mercury SUVs as well as Windstar minivans qualified as low-emission vehicles. Starting last year, most F-series pickups also qualified. Which means the air out there will be a little bit nicer.

Charles Bankston, Dealer/Believer, likes the idea of low-emission vehicles in a part of the country that cherishes wide open spaces.

*Ford Motor Company*



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to take you where the air is fresh leave some

fresh air for  
the rest of us?



# GEOGR

T H E P E O P L E , P L A C E S , A N D



■ NGS RESEARCH GRANT

## Digging It

*What really happened on Stallings Island?*

A flourishing native population lived about 4,500 years ago on Stallings Island, Georgia—and then disappeared a thousand years later. Now Society grantee Kenneth Sassaman is working to find out why. “I think they outstripped the ability of local environments to sustain them,” says the archaeologist. Overharvesting of shellfish, deforestation, and trouble with other tribes, he says, may have led to the island’s abandonment.

The 1.3-acre site on an island in the Savannah River has been the focus of intermittent study since the mid-1800s but had never been accurately dated. Looters have also left their mark; the landscape is pocked with nearly 200 haphazard digs (right). “We focused on portions of the site that were particularly damaged by looters,” says Sassaman. “They often stop digging at the point where features such as storage pits appear.” Among the Stallings finds (above): bone pins, arrowheads, and the oldest pottery yet found north of Mexico. The sherds date from about 2500 B.C. and represent a shift from hunter-gatherer culture to a more settled lifestyle.

BOTH BY KENNETH GARRETT



# APHICA

CREATURES OF OUR UNIVERSE





## MARINE CONSERVATION

## Great Lakes Wrecks Preserved

Lake Huron sanctuary spotlights Thunder Bay

An icy graveyard for more than a hundred shipwrecks was protected last year as Thunder Bay National Marine Sanctuary and Underwater Preserve. Covering 448 square miles of Lake Huron east of Michigan's Lower Peninsula,

the marine sanctuary is the 13th in the NOAA system.

Sport divers can explore wrecks such as the *Grecian*, where a control wheel comes to light about 75 feet deep (above). On June 7, 1906, the freighter struck a rock and limped into



HISTORICAL COLLECTIONS OF THE GREAT LAKES, BOWLING GREEN STATE UNIVERSITY, OHIO (INSET); BILL AND RUTHANN BECK

De Tour, Michigan, then sank. Raised and patched up, the *Grecian* was under tow to Detroit a week later for extensive repairs when a storm sank her for good off Thunder Bay. The 296-foot steel bulk carrier (inset) was built in 1891 in a style called a turtleback, distinguished by its rounded forward decks.

"Great Lakes shipping lanes were very congested in those days," says Michigan State Archaeologist John Halsey. "There were lots of collisions."

## ALMANAC

## February

Groundhog Day stems from Candlemas Day, observed for centuries in parts of Europe on February 2. Said the Scots: If Candlemas Day is bright and clear / There'll be two winters in the year.

By the 1840s the idea had caught on in the U.S. If the groundhog sees its shadow on a "bright and clear" day, six more weeks of winter are ahead.



ART BY MATTHEW FREY



NATIONAL GEOGRAPHIC PHOTOGRAPHER JODI COBB

## CULTURE

## More Than Just a Tiny Timbre

Ukuleles were first crafted in Hawaii in 1879 by Portuguese immigrants, and their plinking sound—the instrument's name means "jumping flea"—has been synonymous with the islands ever since. New interest in Hawaiian culture has triggered a big boom for the little strings. Last summer Waikiki's 30th Annual Ukulele Festival featured more than 900 performers, including a ukulele orchestra 300 children strong (above). Selections ranged from the "Menehune Beach Bum Boogie" to "Oye Como Va."



For people with type 2 diabetes

 **Avandia**<sup>®</sup>  
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Strengthen your body's own ability  
to control blood sugar.

**"I manage my type 2 diabetes through diet, exercise  
and medication."**

"The medication my doctor prescribed is *Avandia*. *Avandia* works differently from most other diabetes medications. It strengthens my body's ability to use its own natural insulin more effectively for long-lasting improvement in blood sugar control. I can feel comfortable taking *Avandia* tablets because they're safe to take as prescribed once or twice a day."

*Avandia*, along with diet and exercise, helps improve blood sugar control. It may be prescribed alone, with Glucophage<sup>®</sup> (metformin HCl tablets), or with sulfonylureas, such as Amaryl<sup>®</sup> (glimepiride tablets) and Glucotrol XL<sup>®</sup> (glipizide).

In studies, the most common side effects included cold-like symptoms and headache. A small percentage of people experienced anemia and/or mild to moderate swelling of their legs or ankles. If you experience these or other symptoms, talk to your doctor.

## I am stronger than diabetes

When taking *Avandia* with a sulfonylurea you may be at risk for low blood sugar. Ask your doctor whether you need to adjust your sulfonylurea dosage.

While taking *Avandia*, follow your doctor's guidelines for periodic liver monitoring. If you experience nausea, vomiting, stomach pain, tiredness, anorexia, dark urine or yellowing of the skin, talk to your doctor immediately. Also, talk to your doctor if you experience shortness of breath or an unusually rapid increase in weight. Tell your doctor if you have a history of congestive heart failure or edema. Please see important patient information on the following page.

If you are a premenopausal woman who is not ovulating, you should know that *Avandia* therapy may result in resumption of ovulation, which may increase your chances of becoming pregnant. Therefore, you may need to consider birth control options. Talk to your doctor before taking *Avandia* if you are nursing, pregnant or thinking about becoming pregnant.

For improved blood sugar control, follow the diet, exercise, weight-loss and medication plan recommended by your doctor and test your blood sugar regularly.

**If you have type 2 diabetes, talk to your doctor.  
Or for more information, call  
1-800-AVANDIA. [www.avandia.com](http://www.avandia.com)**

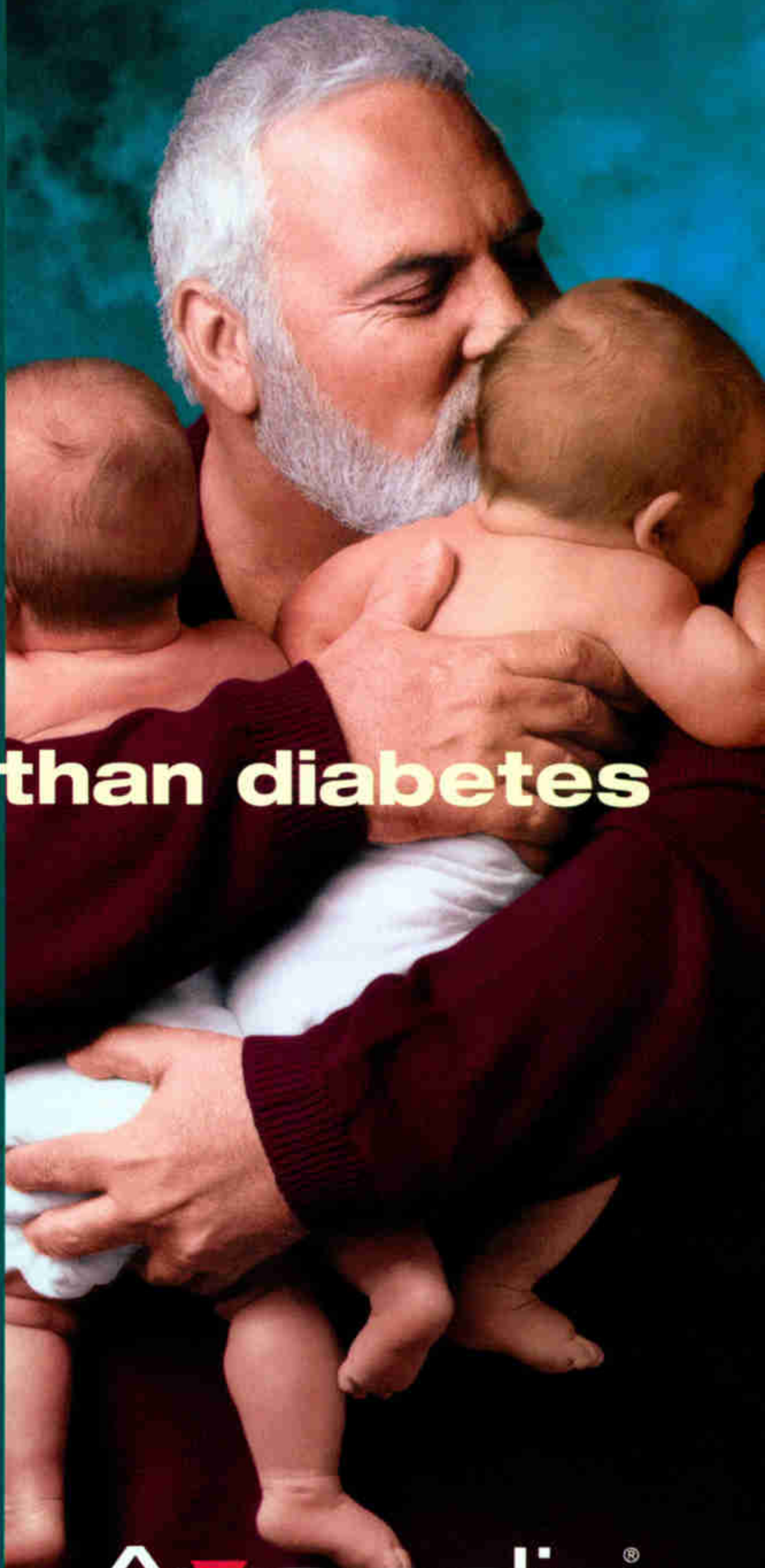
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 **Avandia**<sup>®</sup>  
rosiglitazone maleate

**Help use the natural insulin in you.**





## Patient Information About AVANDIA® (rosiglitazone maleate) Tablets 2 mg, 4 mg, and 8 mg

### What is *Avandia*?

*Avandia* is one product in a new class of prescription drugs called thiazolidinediones (thigh-a-zoe-lid-eeen-die-owns). It is used to treat type 2 diabetes by helping the body use the insulin that it is already making. *Avandia* comes as pills that can be taken either once a day or twice a day to help improve blood sugar levels.

### How does *Avandia* treat type 2 diabetes?

If you have type 2 diabetes, your body still produces insulin but it is not able to fully use the insulin. Insulin is needed to allow sugar to be carried from the bloodstream into many cells of the body for energy. If insulin is not being used correctly, sugar does not enter the cells very well and builds up in the blood. If not controlled, the high blood sugar level can lead to serious medical problems, including kidney damage, blindness and amputation.

*Avandia* helps your body use insulin by making the cells more sensitive to insulin so that the sugar can enter the cell.

### How quickly will *Avandia* begin to work?

*Avandia* begins to reduce blood sugar levels within 2 weeks. However, since *Avandia* works to address an important underlying cause of type 2 diabetes, insulin resistance, it may take up to 12 weeks to see the full effect. If you do not respond adequately to your starting dose of *Avandia*, your physician may increase your daily dose to improve your blood sugar control.

### How should I take *Avandia*?

Your doctor may tell you to take *Avandia* once a day in the morning or twice a day in the morning and evening. It can be taken with or without meals. Food does not affect how *Avandia* works. To help you remember to take *Avandia*, you may want to take it at the same time every day.

### What if I miss a dose?

If your doctor has prescribed *Avandia* for use once a day:

- As soon as you remember your missed dose, take one tablet anytime during the day.
- If you forget and go a whole day without taking a dose, don't try to make it up by adding another dose on the following day. Forget about the missed dose and simply follow your normal schedule.

If your doctor has prescribed *Avandia* for use twice a day:

- As soon as you remember the missed dose, take one tablet.
- Take the next dose at the normal time on the same day.
- Don't try to make up a missed dose from the day before.
- You should never take three doses on any single day in order to make up for a missed dose the day before.

### Do I need to test my blood for sugar while using *Avandia*?

Yes, you should follow your doctor's instructions about your at-home testing schedule.

### Does *Avandia* cure type 2 diabetes?

Currently there is no cure for diabetes. The only way to avoid the effects of the disease is to maintain good blood sugar control by following your doctor's advice for diet, exercise, weight control, and medication. *Avandia*, alone or in combination with other prescription drugs,

may improve these other efforts by helping your body make better use of the insulin it already produces.

### Can I take *Avandia* with other medications?

*Avandia* has been taken safely by people using other medications, including other antidiabetic medications, birth control pills, warfarin (a blood thinner), Zantac® (ranitidine, an antiulcer product manufactured by Glaxo Wellcome Inc.), certain heart medications, and some cholesterol-lowering products. You should discuss with your doctor the most appropriate plan for you. If you are taking prescription or over-the-counter products for your diabetes or for conditions other than diabetes, be sure to tell your doctor. Sometimes a patient who is taking two antidiabetic medications each day can become irritable, lightheaded or excessively tired. Tell your doctor if this occurs; your blood sugar levels may be dropping too low, and the dose of your medication may need to be reduced.

### What should I discuss with my doctor before taking *Avandia*?

You should talk to your doctor if you have a history of edema, liver problems or congestive heart failure, or if you are nursing, pregnant or thinking of becoming pregnant. If you are a premenopausal woman who is not ovulating, you should know that *Avandia* therapy may result in the resumption of ovulation, which may increase your chances of becoming pregnant. Therefore, you may need to consider birth control options.

### What are the possible side effects of *Avandia*?

*Avandia* was generally well tolerated in clinical trials. The most common side effects reported by people taking *Avandia* were upper respiratory infection and headache. As with most other diabetes medications, you may experience an increase in weight (3 to 8 pounds). This often occurs with improved blood sugar control. *Avandia* may also cause edema and/or anemia. If you experience any swelling of your extremities (e.g., legs, ankles) or tiredness, notify your doctor. Talk to your doctor if you experience shortness of breath or unusually rapid increase in weight.

### Who should not use *Avandia*?

The following people should not take *Avandia*: People with type 1 diabetes, people who experience yellowing of the skin with Rezulin® (troglitazone, Parke-Davis), people who are allergic to *Avandia* or any of its components and people with diabetic ketoacidosis.

### Why are laboratory tests recommended?

Your doctor may conduct blood tests to measure your blood sugar control. In addition, your doctor may conduct liver enzyme tests. *Avandia* did not show signs of liver problems in studies. However, because a related drug (*Rezulin*) has been associated with such problems, and because *Avandia* has not been widely used, your doctor may recommend a blood test to monitor your liver before you start taking *Avandia*, every 2 months during the first year and periodically thereafter.

It is important that you call your doctor immediately if you experience nausea, vomiting, stomach pain, tiredness, anorexia, dark urine, or yellowing of the skin.

### How should I store *Avandia*?

*Avandia* should be stored at room temperature in a childproof container out of the reach of children. Store *Avandia* in its original container.

DATE OF ISSUANCE MAY 2000

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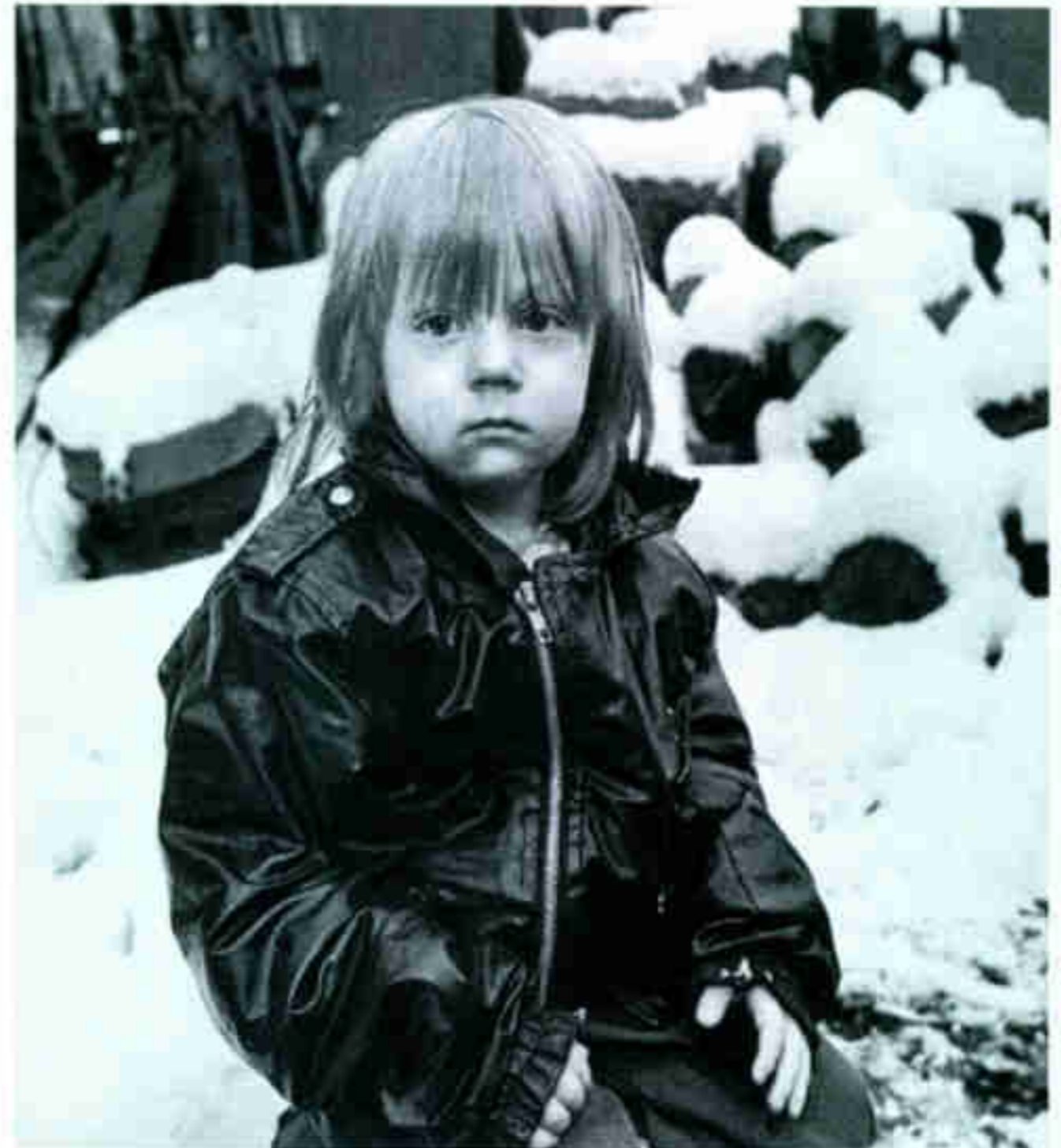
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# Behind the SCENES

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KIKE ARNAL

## Elevation Anxiety

*Filmmaker wins top award after defeating his fears*

**T**im Scoones admits he's terrified of heights. "I go pale, I shake, my heart races, my knees knock," he says. But the British documentary producer (above, far right, with

scientist Jay Malcolm and cinematographer Neil Rettig) forced himself up into rain forest canopies again and again, as here in Brazil, for the National Geographic Special *Exploring the*

*High Frontier*. The film won an Emmy last fall in the category of outstanding information or cultural programming. Emmys also went to National Geographic EXPLORER films *War Child*, about the Kosovo conflict; *Racing the Distance Update*, about a balloon flight; and *Hitting the Wall*, which documented the ascent of a Baffin Island peak.

## Maps To Go

**H**ikers, bikers, and other outdoor enthusiasts now can buy a useful new tool: topographic maps based on U.S. Geological Survey data centered specifically on the area they need. At this L.L. Bean store in Virginia (right) and at National Geographic Maps kiosks in retail stores coast to coast, computers produce individualized topographic maps for any part of the continental United States on waterproof, tear-resistant paper—in less than ten minutes.



MARIA STENZEL



Photo By: David Doubilet

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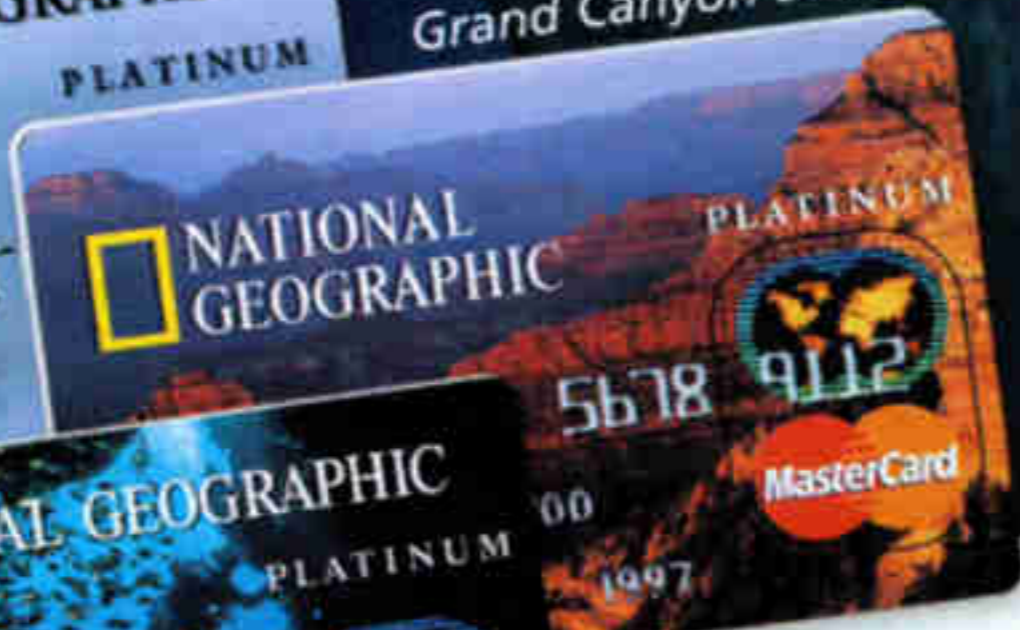
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## Scouting Life

*Girls record street scenes*

**W**ith camera—not cookies—in hand, Girl Scout Tenisha Morrow, 15, hit the street last August. Here snapping a cooperative passerby with help from Geographic photographer Mark Thiessen, she was one of 19 Washington, D.C., area Girl Scouts who completed a week-long geography workshop at National Geographic Society headquarters. The program kicked off an educational partnership between the Society and the Girl Scouts of the USA.

Society writers, photographers,



HEATHER R. HOFFMAN, NGS

and web staff gave the Scouts hands-on experience gathering information and making photographs and videos of northwest Washington's Georgia

Avenue neighborhood, the site of a five-year renovation initiative. The girls' efforts are on view at [nationalgeographic.com/girlscouts](http://nationalgeographic.com/girlscouts).

## Tales from the Field

**N**evada Wier (right), who photographed the Blue Nile expedition for our December 2000 issue, is among the authors, photographers, and explorers featured in this season's *Live... from National Geographic* series. Presented in Washington, D.C., since 1888, Society lectures now tour to Seattle, Cincinnati, and—new this year—the Chicago area.



MICHAEL DAVIE

### 100 YEARS AGO



February 1901

"That well-worn phrase, 'The world of empire westward wends its way,' is destined to be contradicted by the growth of Russia during the present century. One hundred years from now it is almost safe to predict the center of the Russian Empire in influence and enterprise, if not in population, will be east of the Ural Mountains."  
—*Geographic Notes*

## High-level Reading

**R**ussian cosmonaut Vladimir Dezhurov reads NATIONAL GEOGRAPHIC whenever he has time—and he had plenty during his 115-day stint aboard the Mir space station in 1995. The issue he took up then resurfaced recently (below) while Vladimir was in



MARSEL GUBAIDULLIN

training at Star City, the space complex in Russia. Plans are on for him to command a flight to the International Space Station, so he'll have to lay in a fresh supply of magazines.

### FOR MORE INFORMATION

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Feel lucky? Test your conservation IQ and you could go along on an explorer-led National Geographic expedition. Try your hand at [nationalgeographic.com/earthpulse](http://nationalgeographic.com/earthpulse).

### ■ MARS

The red planet is actually yellowish brown. See NASA's astonishing images taken only 240 miles above the surface at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).

### ■ UNDERGROUND RAILROAD

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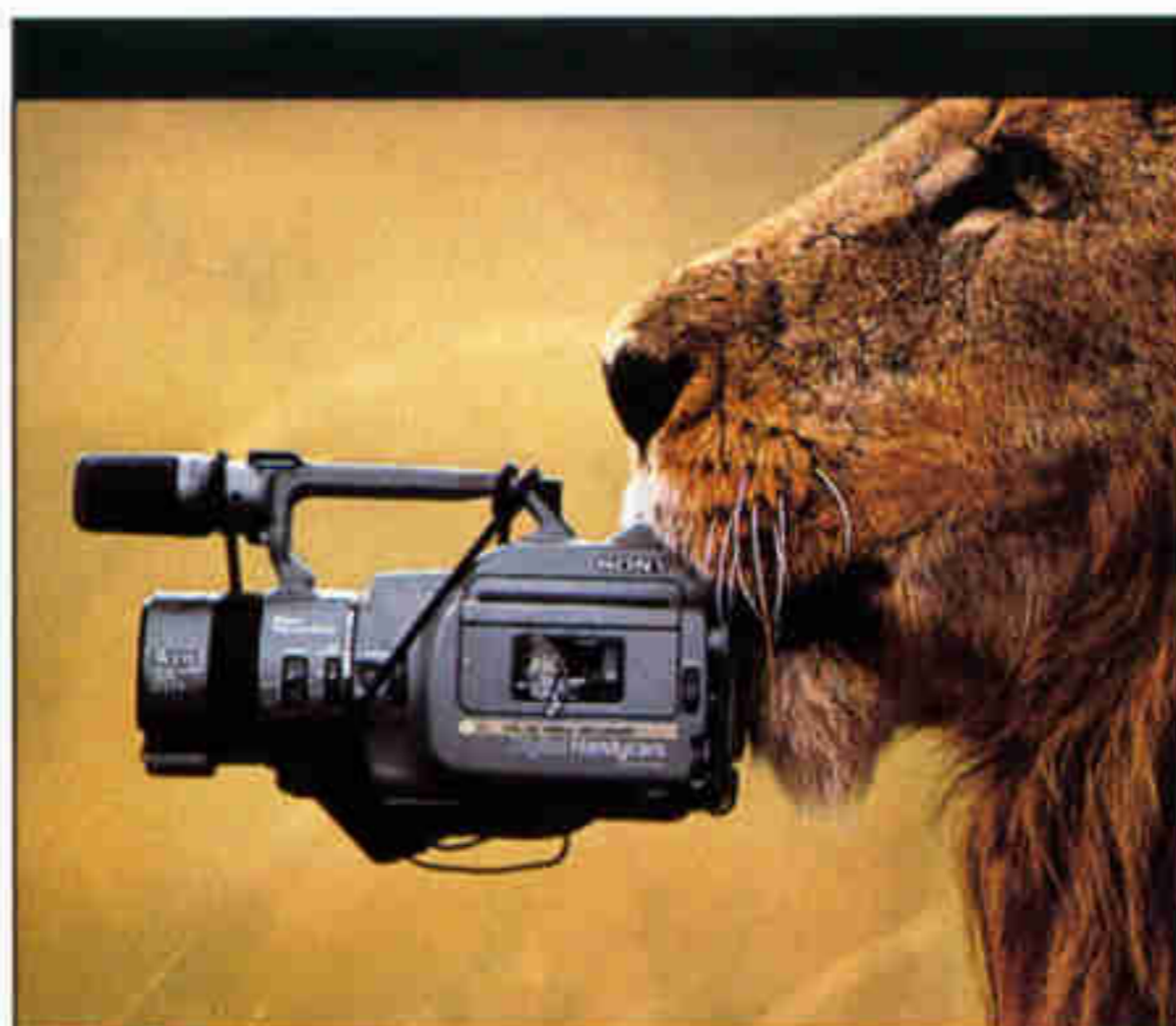
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NGS PHOTOGRAPHER MICHAEL NICHOLS

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## Taking the Heat

What does it feel like to face down a raging forest fire in the American West? Learn what has drawn firefighter Norbert Schuster back to the edge of danger year after year. *Fire Call* and other accounts of courage await you at our Adventure & Exploration Guide. Feel the thrill at [nationalgeographic.com/explore](http://nationalgeographic.com/explore).



NGS PHOTOGRAPHER MARK THIESSEN

## Bushmen

Hear the distinctive "click" speech of this southern African people, and see scenes of everyday life as photographer Chris Johns reveals Bushman culture at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).



NGS PHOTOGRAPHER CHRIS JOHNS



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NATIONAL GEOGRAPHIC CHANNEL, FEBRUARY 19

## Nature's Ferocious Way

**D**anger darkens the sky as a tornado tears across the plains in *Cyclone!*, one of the gripping programs featured in *National Geographic's Extreme Planet Marathon*, a back-to-back showing of natural disaster films. Avalanches, volcanoes, and earthquakes all make a tumultuous appearance.



NOAA (TOP); JOANNE BOREK

EXPLORER, FEBRUARY 4

### Dog Day

**F**our-legged stars, from greyhounds (above) to pugs, take the stage in *Top Dogs!*, a front-row view of America's premier canine pageant, the Westminster dog show in New York City.



GEORGE F. MOBLEY

COMING SOON ON PBS

## Serious Risks

**A**sudden storm, an overloaded boat, frigid seas: The elements of disaster await today's commercial fishermen desperate to succeed in an increasingly high-pressure business. *Mayday! Lost at Sea* examines the perils of working in turbulent waters and the bravery of rescue crews, such as this Coast Guard team (left). The National Geographic Special also looks at how fishing communities deal with tragedy and the ways fishermen try to increase their odds in unforgiving seas.

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# AskUs

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**What makes this heart so fragile?**

*Think you know the answer? Go online to [nationalgeographic.com/ngm/tellus/0102](http://nationalgeographic.com/ngm/tellus/0102) and test yourself, or read it here in next month's issue.*

### January Answer

Marigolds are dropped during a celebration at a Hindu temple in Texas.

DAVID DOUBILET

## THE ANSWER PLACE

Our Research Correspondence staff responds to questions from curious readers.

**Q** I recently saw the Hope Diamond at the Smithsonian Institution's National Museum of Natural History. Is it the world's largest?

**A** No. The Golden Jubilee Diamond, which weighs 545.67 carats, is the largest cut diamond in the world. In 1996 Thai subjects presented this yellow diamond to their king, Bhumibol Adulyadej, to commemorate his 50th year on the throne. The Hope Diamond, by contrast, weighs 45.52 carats.

**Q** What does a giraffe do with its head and neck when it sleeps?

**A** Giraffes sleep only about 30 minutes a day, although they also doze while standing, drooping their necks. Even if they lie down, necks folded against their flanks, they sleep for only about three minutes at a time.

**Q** How did people make ice before refrigeration?

**A** In India and Egypt bowls of water set into the ground froze at night as a result of cooling evaporation. In other places

people cut ice from frozen lakes or gathered mountain snow and stored it insulated with straw or other material. Mechanical refrigeration was developed in the mid-1800s.

## MORE INFORMATION

Send questions to Ask Us, National Geographic Magazine, PO Box 96095, Washington, DC 20090-6095 or via the Internet to [ngsaskus@nationalgeographic.com](mailto:ngsaskus@nationalgeographic.com). Include name, address, and daytime phone number.

## CARTOGRAPHIC

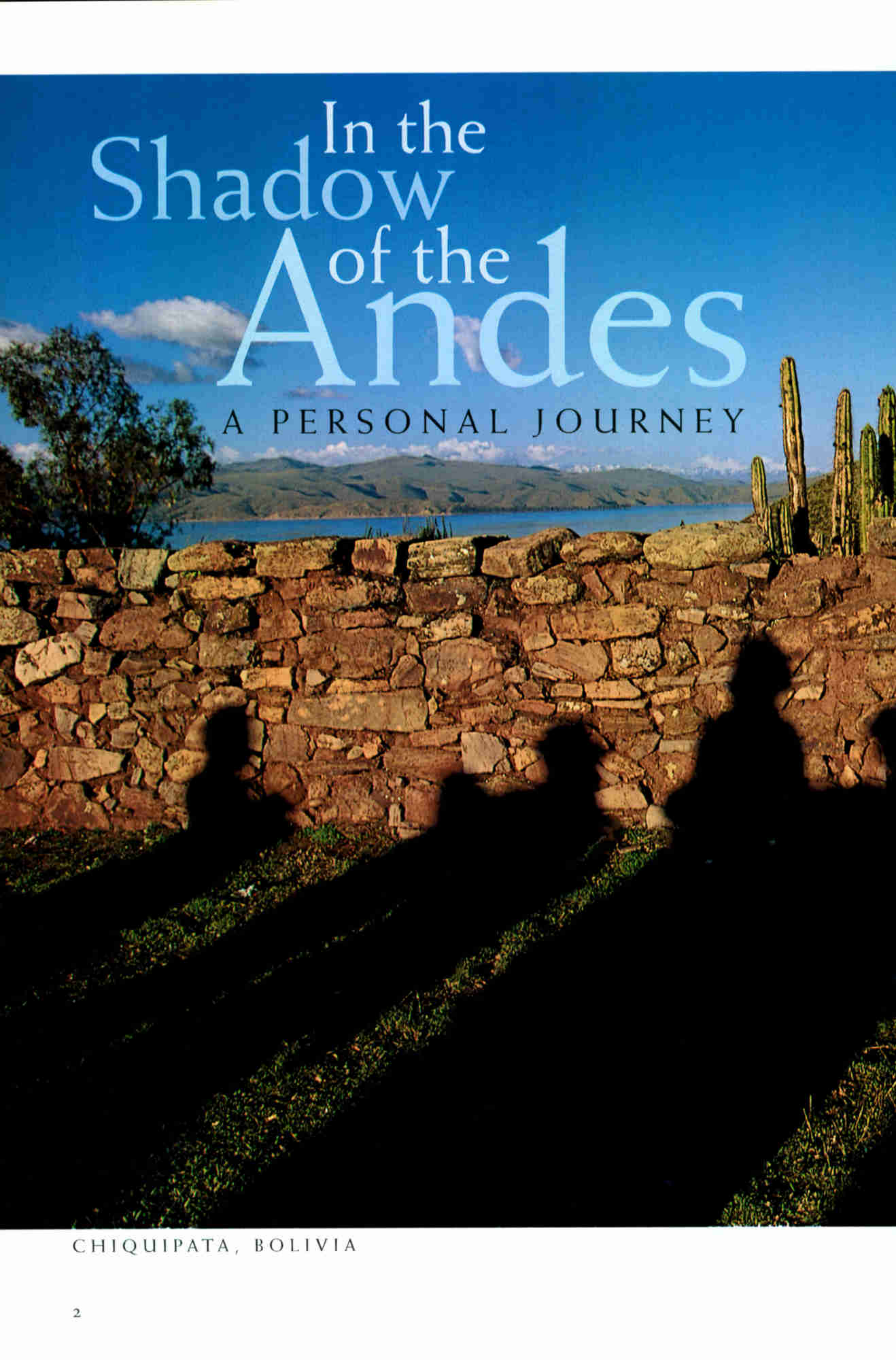
**Q** What is the world's saltiest lake?

**A** The Dead Sea (really a lake) is up to nine times saltier than the oceans. It lies 1,349 feet below sea level, the lowest spot on Earth.



NG MAPS; IMAGE BY WORLDSAT INTERNATIONAL INC.



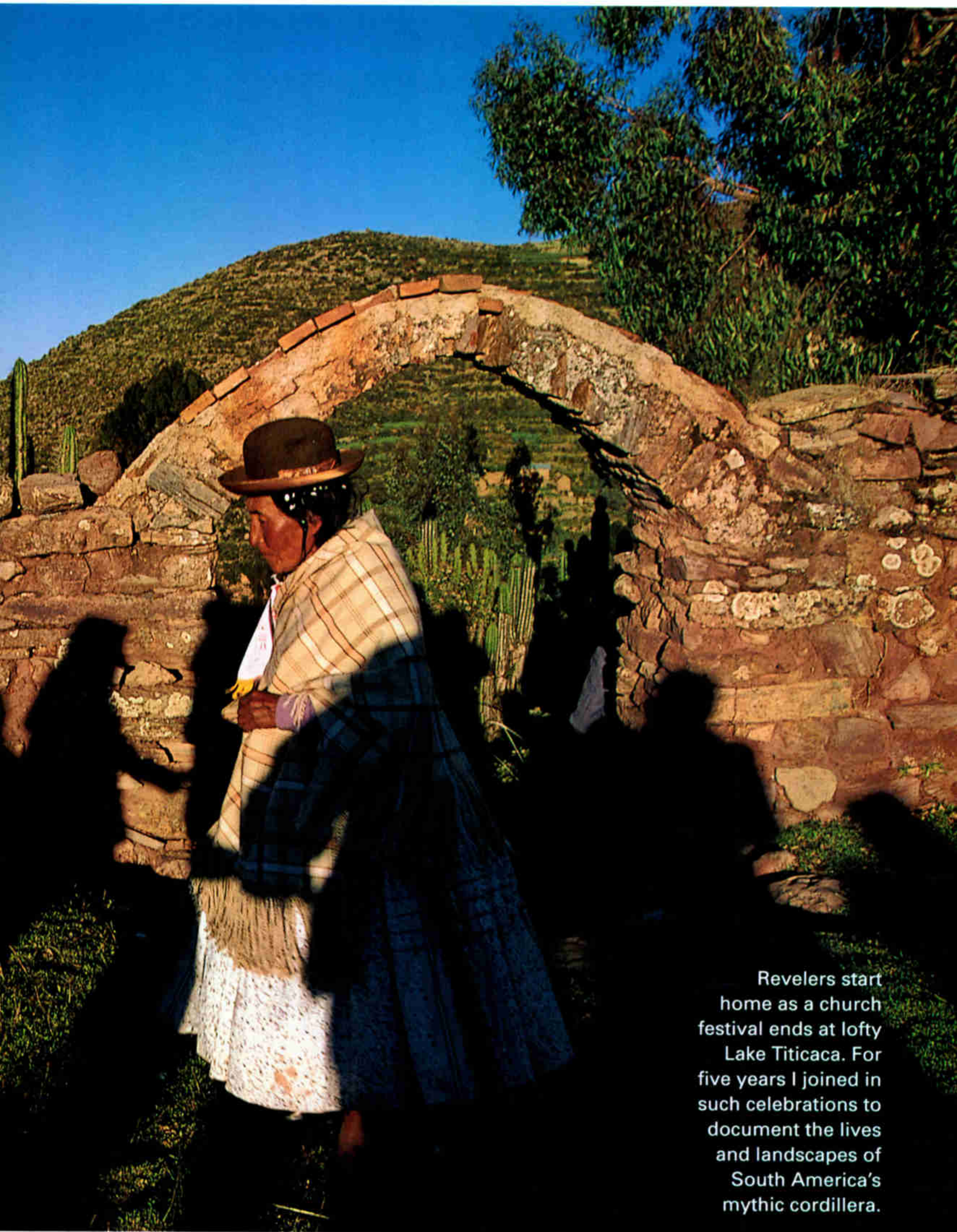


# In the Shadow of the Andes

A PERSONAL JOURNEY

CHIQUIPATA, BOLIVIA

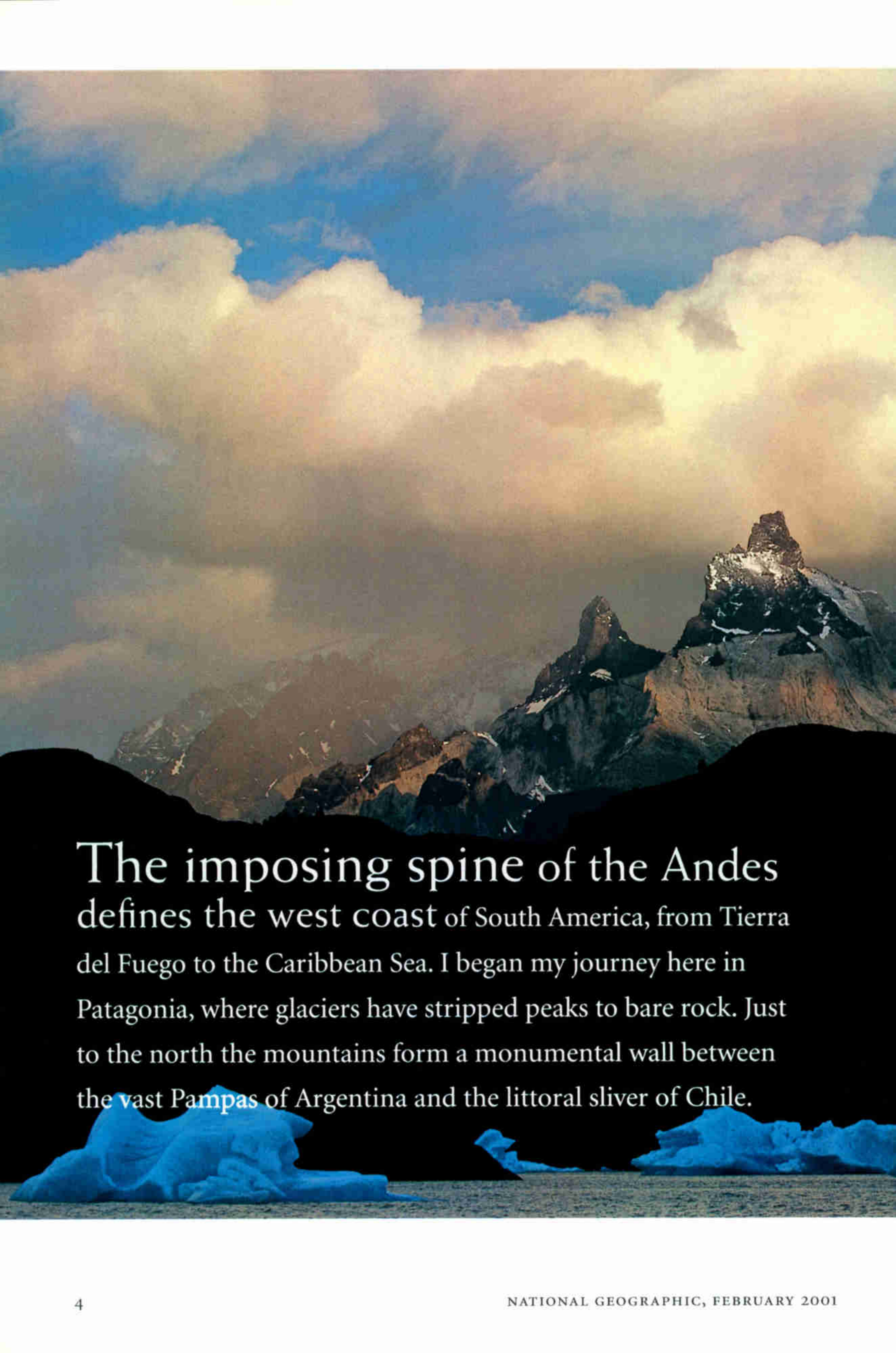




Revelers start home as a church festival ends at lofty Lake Titicaca. For five years I joined in such celebrations to document the lives and landscapes of South America's mythic cordillera.

ARTICLE AND PHOTOGRAPHS BY PABLO CORRAL VEGA





The imposing spine of the Andes defines the west coast of South America, from Tierra del Fuego to the Caribbean Sea. I began my journey here in Patagonia, where glaciers have stripped peaks to bare rock. Just to the north the mountains form a monumental wall between the vast Pampas of Argentina and the littoral sliver of Chile.





PAINE PEAK AND GREY LAKE, CHILE



I was born in the Andes, in the colonial city of Cuenca, Ecuador. The mountains have been my lifelong companions, and I still make my home at their feet. To those of us who are their children, they are alive. We listen to them, learn to read their moods, and respect their power. Sometimes they welcome us with their solid embrace. Other times they shake with fury, and we know to stay away. Still sacred to some, they speak to the souls of all, reminding us how vulnerable we are. There are millions of us, brown, white, and black, mestizo and mulatto, and we have all labored to help build this continent of sadness, magic, and irrepressible hope.

VIÑA DEL MAR, CHILE (BOTH)







**Chile** *Bastions of society, the family and the armed forces have each undergone radical changes in the past decade. Looking after children was once exclusively women's work. Today young parents both pitch in. On a Saturday outing with his daughters, Rodrigo Abarca holds María Jesús while Macarena sits for a portrait (left). "They can really exasperate me, but I love spending time with them," he told me.*

*Still wielding great power, the Chilean military now operates under civilian authority. In the annual promotion ceremony at the Naval Weapons School, a Roman Catholic chaplain blesses the swords of new officers, who swear to defend the democratic constitution.*





MOUNT ACONCAGUA, ARGENTINA (22,835 FEET)

Over the months and miles I realized that my kinship extends to every part of the continent united by the history, language, and religion of the conquistadores. And yet, as close as we South Americans feel to one another, we also sense a strangeness. The mountains have been boundaries, allowing different cultures to grow up in proximity.

Closely identifying with European cultures, Chileans and Argentines view the Andes as a spectacular backdrop. Few live in the jagged heights, which become bitterly cold in winter.

From Bolivia to Venezuela, though, tropical air produces a transformation, making the high country habitable. The gradual cooling that comes with altitude brings a profusion of ecosystems to the short distance between the rain forests and the summits.

These variations in nature have parallels in human society: an explosion of musical forms and culinary specialties, native tongues and dialects, lifestyles and clothing styles, traditions and attitudes—all connected in the end by the lingering influence of Spanish rule.





In a continent of extremes, including the largest rain forest and driest desert, Earth's longest mountain range dominates the geography of seven countries. Set elsewhere, the 5,500-mile-long Andes would stretch from San Francisco to London. Only the Himalaya reach higher than these snowy peaks.





Fighting cold and loneliness, Bolivian soldiers still





SAJAMA, BOLIVIA

patrol the border more than a century after a war with neighboring Chile.



I've seen crowds everywhere,  
people who want change, who want  
a future for their family, a better life.

When the masses dream,  
they form rivers of hope.

---

TIWANACU, BOLIVIA







COPACABANA, BOLIVIA



**Bolivia** *In the tropical latitudes, where rainy and dry seasons alternate, festivals mark the year's cycles while bringing people together and offering relief from daily routines. Because every community has its own sartorial traditions, a hat's shape or a fabric's design shows where each participant comes from. Shying away from the changes overtaking their culture, Aymara women still dress like their ancestors even when going to town (left). Men, who venture beyond their villages more often, are quicker to adopt modern ways. Dressed in city clothes, a father waits with his family as a priest blesses their van, decorated for a ceremony of thanksgiving.*





**Two worlds** claim a family on a Catholic feast day. After Mass the





PAUCARTAMBO, PERU

celebration moves to the street in a pageant of masked dancers and reed flutes.



## Peru *Pre-Hispanic customs*

*survive stubbornly here in the heart of the Inca Empire. Though dwindling in number, salt peddlers still use the terraced pans of Maras as the Inca did, filling them with spring water and scraping up the white crystals after evaporation.*

*In remote villages I met older people who speak only Quechua, the language of the Inca. They also keep traditions in food, music, and religion that have all but died out in urban areas. Catholicism is part of daily life, but native beliefs and practices suffuse its rituals.*

*On a trip to town a villager removes her hat in respect (below) as a Catholic procession passes by.*



PAUCARTAMBO, PERU





MARAS, PERU





Scattered in a valley surrounded by volcanoes, 1.5 million





QUITO, ECUADOR, AND MOUNT ANTISANA:

Quiteños live with the threat of ash clouds and mudflows.







## Volcanoes *Roiling*

*ash and rings of steam rise from 15,728-foot-tall Guagua Pichincha on the morning of October 7, 1999. No sound or tremor alerted the nearby city of Quito, and wind swept the cloud away quickly. If a friend hadn't called and told me to look out the window of my apartment, I would have missed it.*

*A bigger eruption two days earlier was a different story, with a heavy shower of ash turning day to night for the first time since 1660 (below).*

*Pichincha continues to puff, occasionally closing the airport and schools. We can only clean up behind it and hope the activity will not escalate.*



QUITO, ECUADOR (BOTH)



## Ecuador

*Caring for home and family, and sometimes earning the only income as well, women are now also taking on religious and secular roles from which they were once excluded.*

*In a Good Friday procession commemorating the Passion of Christ, a young woman shoulders the heavy cross, traditionally a man's burden.*

*A successful advertising executive, 30-year-old Verónica Delgado dresses for her wedding. Women of her generation are landing professional jobs in unprecedented numbers. "Sure, we've had to fight chauvinism," she says. "But we've proved that we're capable and that we can handle a career as well as a family."*







QUITO, ECUADOR (BOTH)

It's the end of a millennium. And it's difficult to know what century we are in. These could be medieval rites. Sincere faith touches the very essence of the people.

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**Descendants of Africans** brought to Ecuador in the 16th





EL JUNCAL, ECUADOR

century to work on sugar plantations remain at the margin of society.





LA TEBAIDA, COLOMBIA

**Colombia** *Natural disasters and human conflict have scourged the Colombian Andes. Here the mountains split into three ranges, all prone to earthquakes. On January 25, 1999, a quake killed a thousand people and left 250,000 homeless. “Our house collapsed in seconds,” José Trejos told me as he surveyed the ruins with a granddaughter (above). “It’s a miracle we survived.”*

*Marcela Arias, who used to enjoy Medellín’s nightlife (right), has recently moved to Spain to study fashion design. Fearful of the city’s escalating violence and kidnappings, she wants her mother and brothers to leave the country too.*





For half a century Colombians  
have been caught in a civil war  
involving old resentments,  
acts of vengeance, and clashing  
economic and political interests.

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MEDELLÍN, COLOMBIA





## Caribbean

*Nearing their northern end, the Andes are a cool stroke across Venezuela. Narrow and fractured, they shelter communities such as Jají in high valleys (below). Close by lies a vibrant coast where tropical scents and hot rhythms fill the Caribbean air. As I watched the sun set, I thought of the people who opened their homes to me along the cordillera and of the great lesson they taught me: Hospitality, friendship, the unconditional support of family, and the time we take to share all these things are the most valuable treasures of my people.*

### MORE ON OUR WEBSITE

For more photographs of the Andes and field notes from the journey of Pablo Corral Vega go to [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).



## JAJÍ, VENEZUELA







SANTA MARTA, COLOMBIA

I want to bring the map of the Andes to life with my memories—the smell of fields before harvest, the crystal clarity of a night, the intimacy of conversations on the road. My journey is just beginning. □

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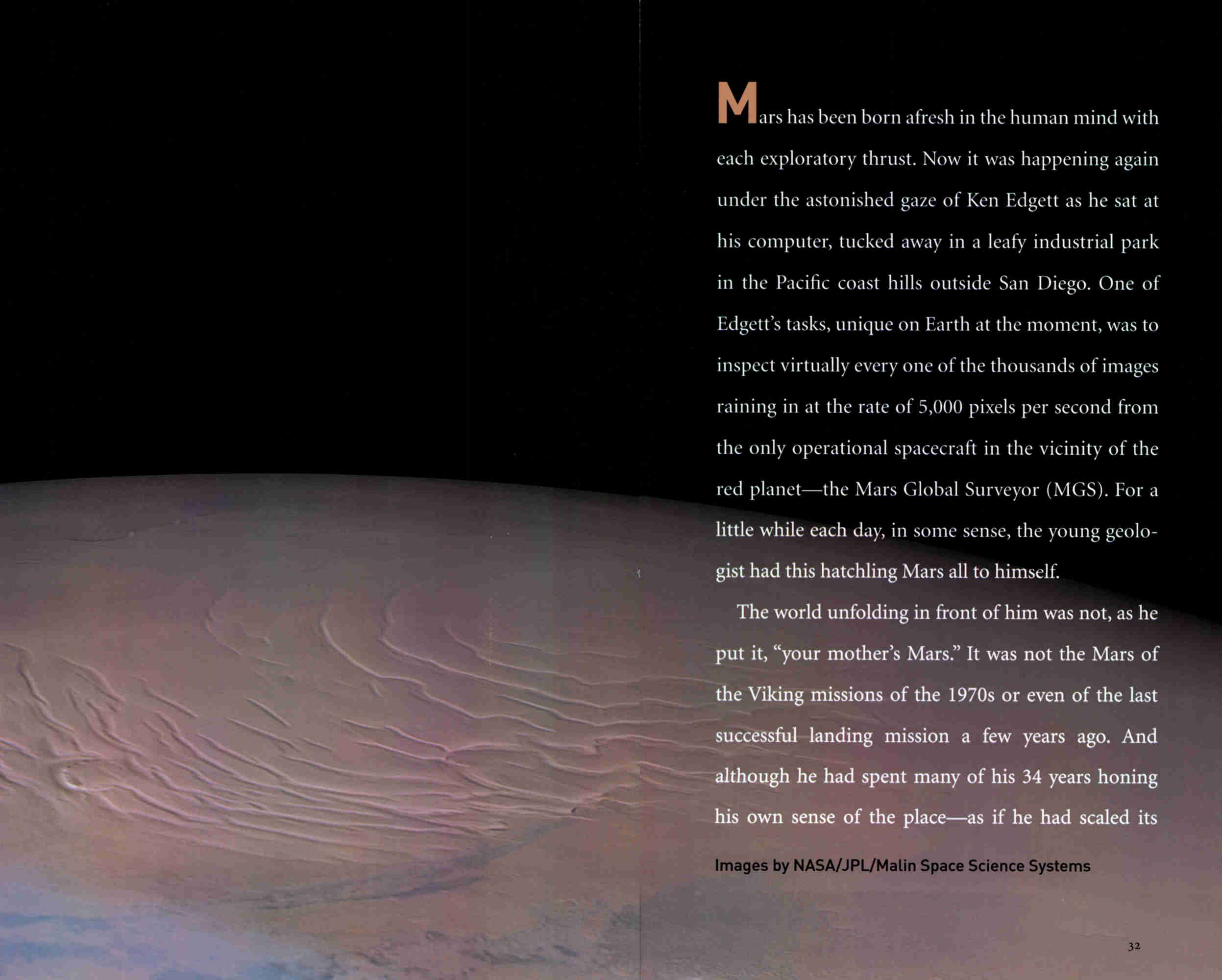


# A Mars Never Dreamed Of

By Kathy Sawyer

The more scientists see of Mars, the more mystified—and astonished—they are about the powerful forces that shape its terrain. Images from the Mars Global Surveyor intensify debates about the role of water and the chances of finding life. They also display beauty, as in this view of the icy polar north.





**M**ars has been born afresh in the human mind with each exploratory thrust. Now it was happening again under the astonished gaze of Ken Edgett as he sat at his computer, tucked away in a leafy industrial park in the Pacific coast hills outside San Diego. One of Edgett's tasks, unique on Earth at the moment, was to inspect virtually every one of the thousands of images raining in at the rate of 5,000 pixels per second from the only operational spacecraft in the vicinity of the red planet—the Mars Global Surveyor (MGS). For a little while each day, in some sense, the young geologist had this hatchling Mars all to himself.

The world unfolding in front of him was not, as he put it, “your mother’s Mars.” It was not the Mars of the Viking missions of the 1970s or even of the last successful landing mission a few years ago. And although he had spent many of his 34 years honing his own sense of the place—as if he had scaled its

Images by NASA/JPL/Malin Space Science Systems



## Creation of Landforms New and Strange

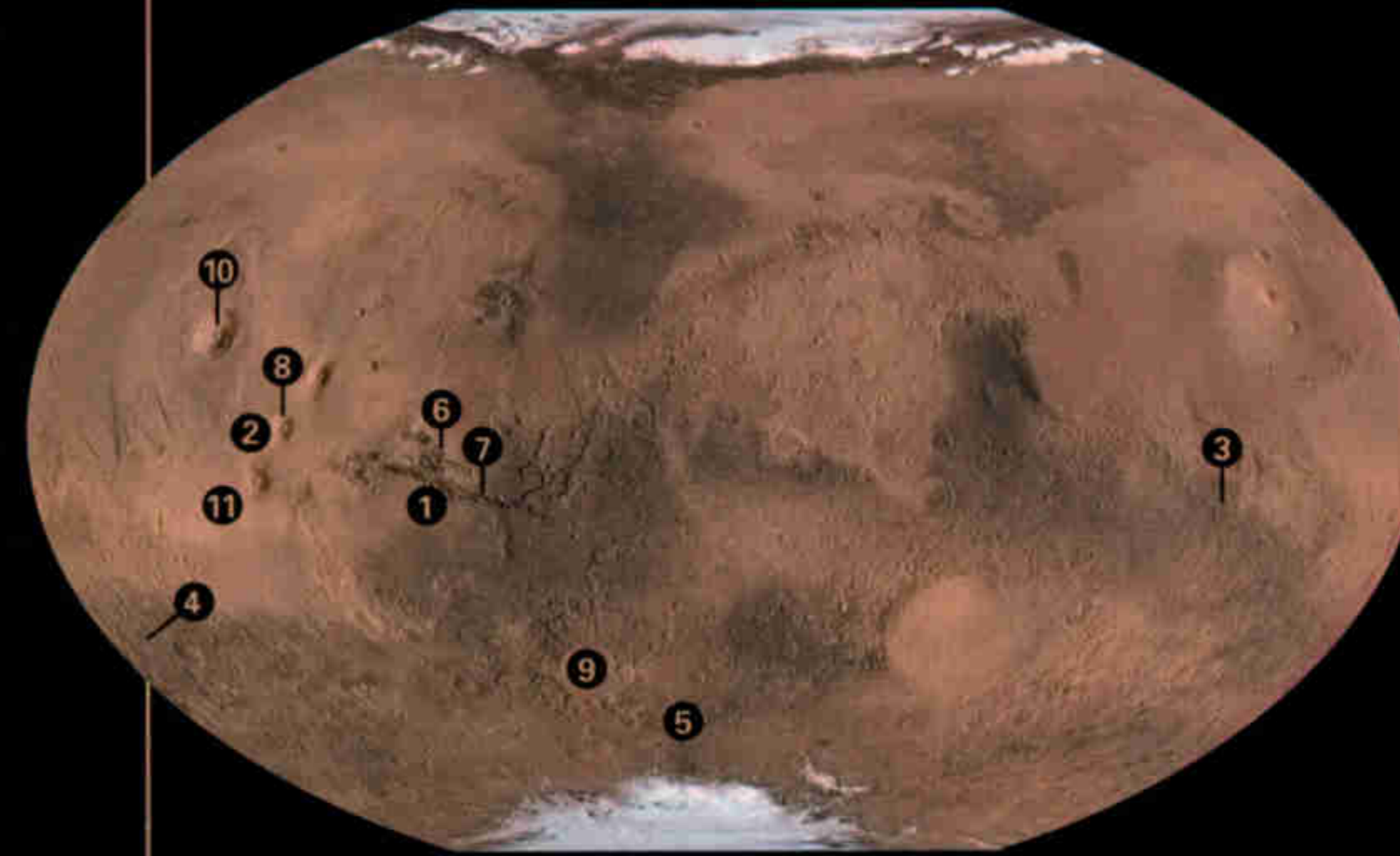
**DURING ITS YOUTH**—the first billion or so years—Mars was an active and violent place. Volcanoes erupted, meteorites blasted craters in the surface, and catastrophic floods carved channels. Over time, faulting and landslides opened the 2,500-mile-long canyon system called Valles Marineris (1). Mars has quieted down since then, but the forces of wind and possibly lava and water still alter the rugged terrain of this 4.5-billion-year-old planet.

Intermittent lava flows, some from Tharsis rise (2)—an enormous volcanic area centered on the

equator—apparently resurfaced large areas of Mars. Winds transported massive amounts of sand and dust, which filled craters and piled up in dune fields. Passing over Herschel basin (3), Surveyor's high-resolution camera photographed an unusual desert. Its dunes (left) appear cemented in place.

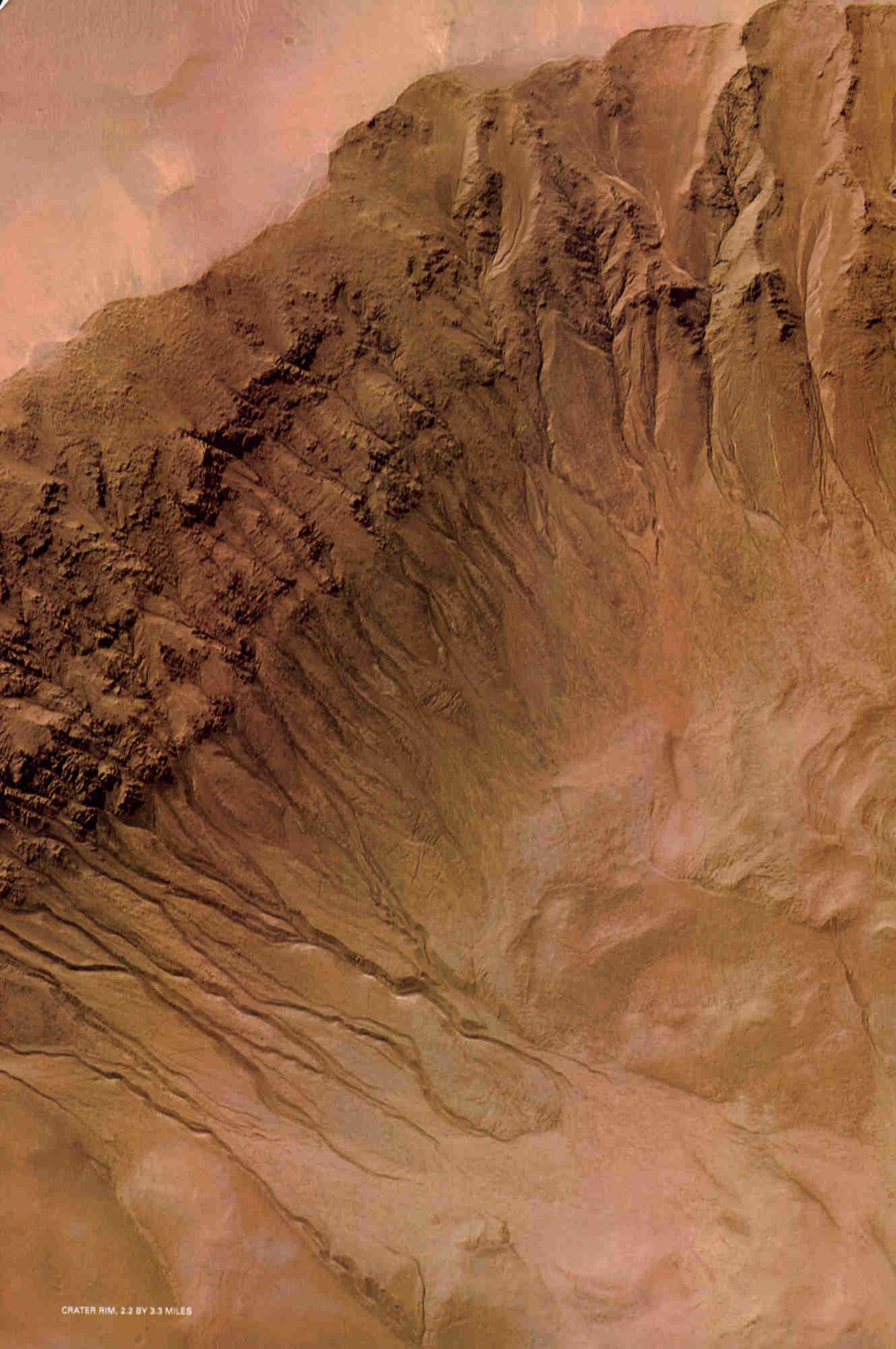
The most surprising images seem to show relatively recent water erosion. Up to now scientists believed that water had not flowed on Mars for billions of years, that it was locked up in the polar ice caps or in deep permafrost layers. Surveyor has upset those notions with images from some 120 sites, including a crater east of Gorgonum Chaos (4). The crater has cliff faces etched with gullies (right) that liquid water mixed with soil, rocks, and ice may have cut.

"The features appear to be so young that they might be forming today," says Michael Malin, designer and lead scientist of the Surveyor camera. "These are landforms that have never been seen before on Mars."



A new map of Mars, made from a mosaic of images and laser altimetry, highlights the planet's mottled look. Numbers locate features pictured in this article.





CRATER RIM, 2.2 BY 3.3 MILES



# “The biggest thing to come out of the MGS

Everest-dwarfing heights, slogged across its frosty dunes, felt the sting of its dust storms, and shaken its fine sand out of his boots—he confessed this Mars shocked even him. “The biggest thing to come out of the MGS images is bafflement,” Edgett said the first morning of my visit. “Much of it doesn’t add up. It’s spine-chilling. It’s . . . mind-boggling!”

In November 1996 when Surveyor was launched, there had been no completely successful mission to Mars in 20 years. Its goal was to assemble a global portrait of the planet over a full Martian year (about two Earth years, or 687 Earth days). A boxy, one-ton craft, it carries, in addition to the camera, a suite of

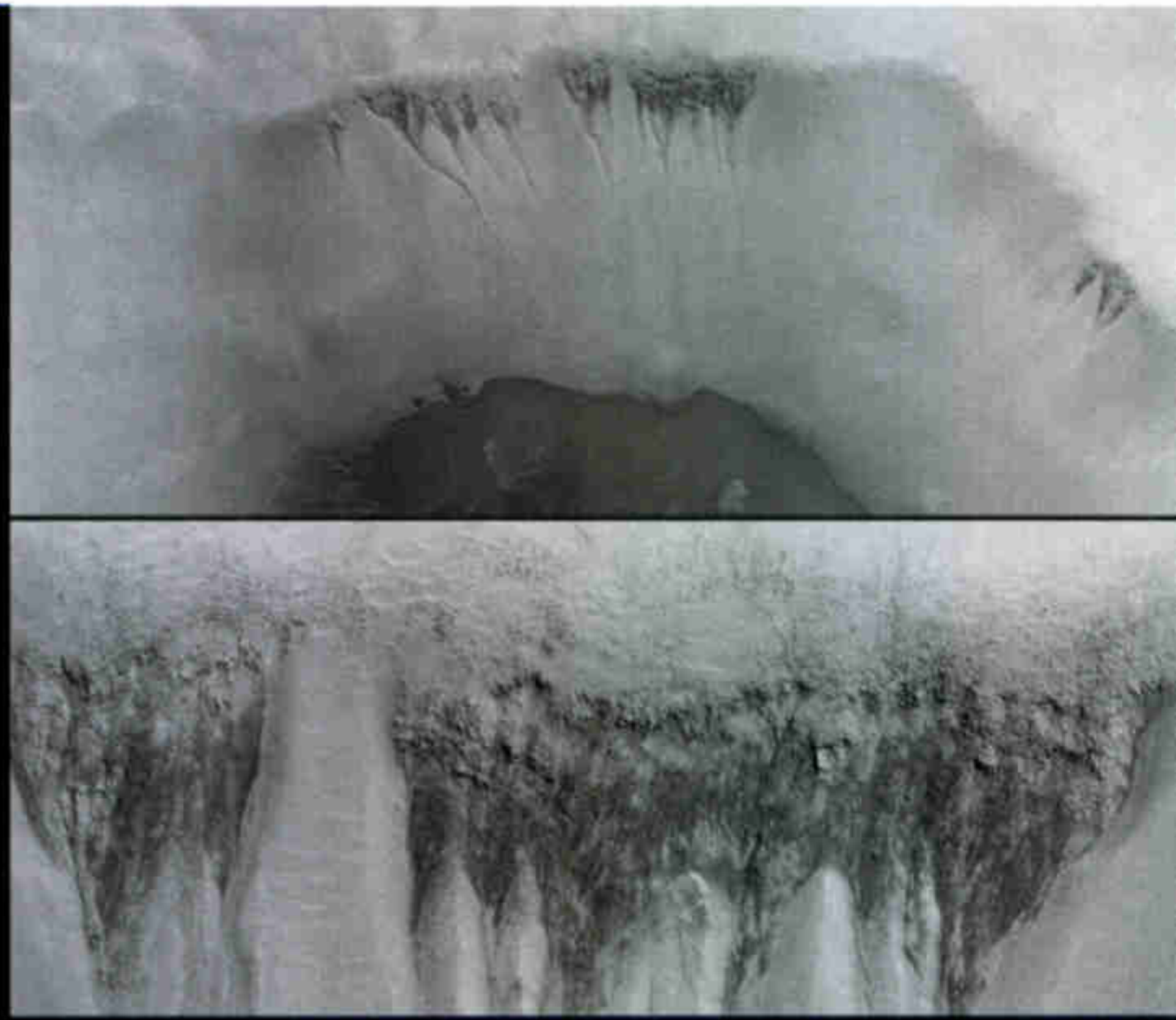
remote-sensing instruments that bounce laser beams off the surface to measure topography, scan for heat emissions to study atmosphere and mineral composition, and probe the planet’s interior through its gravity and magnetism.

Surveyor never attracted the concentrated burst of global acclaim bestowed in 1997 on its charismatic (but scientifically much less ambitious) sister mission, NASA’s Mars Pathfinder with its lander and rock-sniffing sidekick, the rover Sojourner. Slowly and steadily, however, Surveyor fomented its own quiet revolution in scientific understanding of the seemingly most Earthlike planet known.

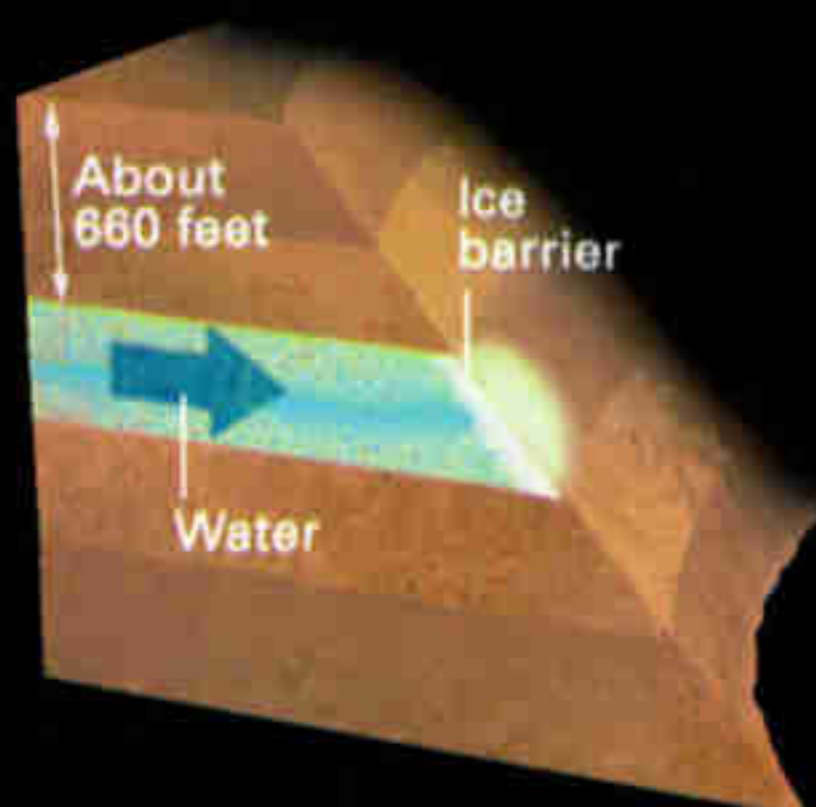
By late 2000 the workhorse camera had

## Watermarks?

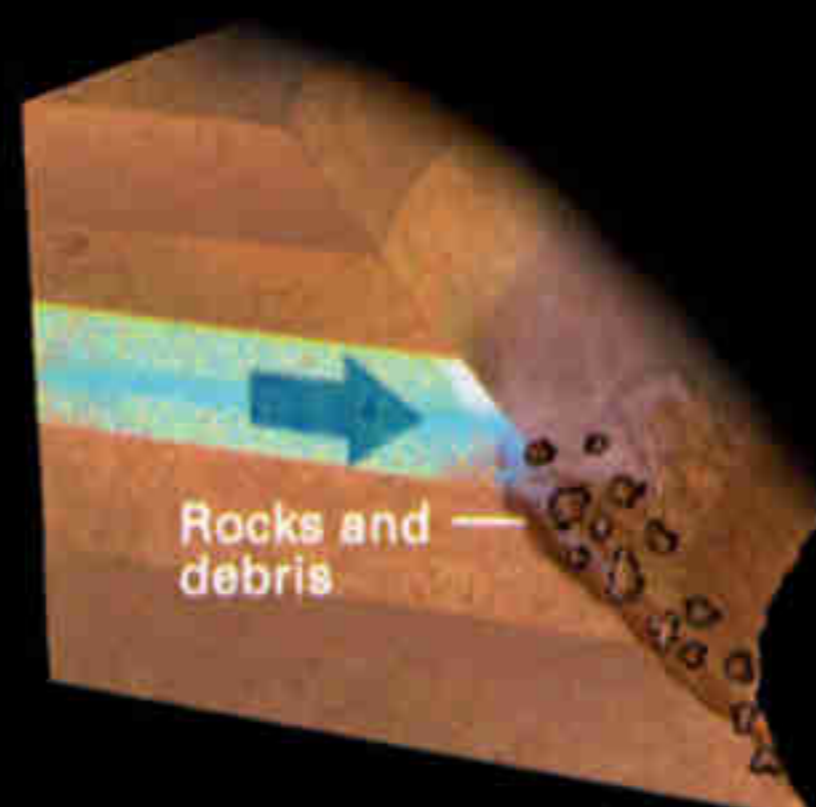
**DARK TRACINGS** on a crater wall (right, top) in Noachis Terra (5) provide the first evidence that water may still flow on Mars. A close-up (right, lower) shows channels that resemble spring-fed drainages on Earth. “If life developed on Mars,” says Malin, a geomorphologist, “these landforms would be great places to look.” A model (below) suggests how water might flow on the frigid planet without evaporating.



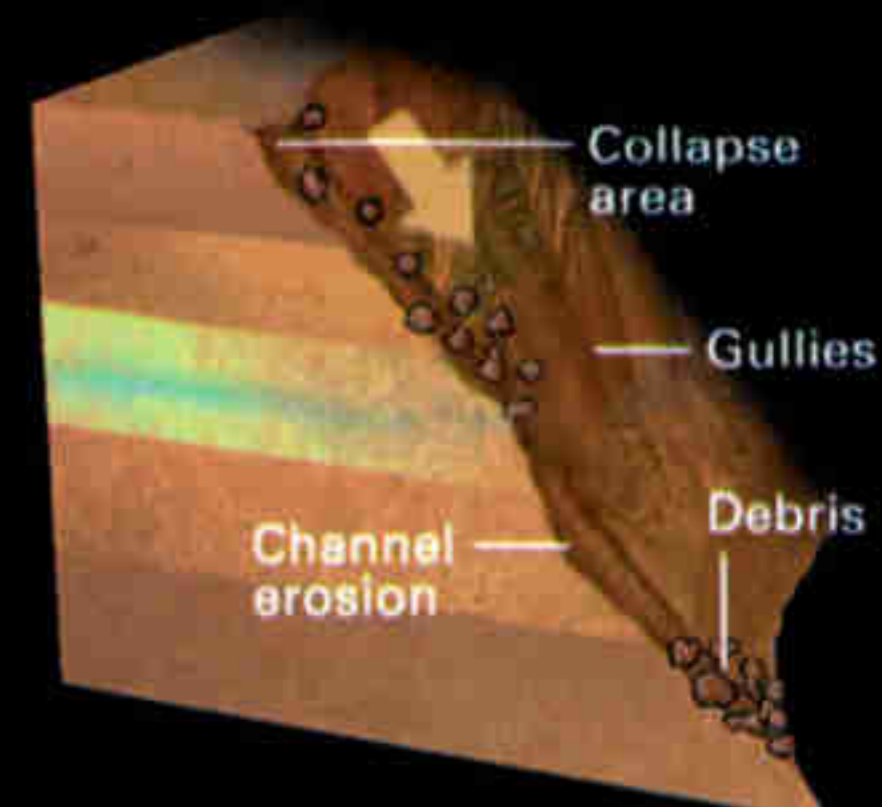
ART BY JOHN ANDERSON, NGM ART



1 Water kept liquid by the pressure of overlying rock seeps toward the surface. Some water freezes as it nears the surface, forming an ice dam.



2 Groundwater builds up pressure behind the ice barrier. Eventually the water bursts out in a torrent too fast to freeze.



3 Collapse of the overlying rock layer produces a landslide. A slurry of rock, water, and ice carves a narrow channel and creates an apron of debris.



## images is bafflement.”

churned out some 80,000 images, on average 50 times as detailed as any previously taken from orbit. Other onboard instruments had mapped the topography and gravity of the entire globe, provided a new understanding of the planet's overall shape, and discovered a puzzling pattern of magnetic strips in the planet's surface—apparent remnants of an ancient global magnetic field. The craft had operated a continuous Martian weather service, recording huge dust storms, the shadows of tornado-like dust devils, and wildly rapid swings from dusty and warm to cold and clear. (At the summit of Olympus Mons, for instance, the typical daily high is 40°F, and the low is minus 165°F.)

Some of the images were, aside from any scientific revelations, simply dazzling displays of nature's art: Byzantine dune-field sculptures, black scrawls etched by Martian dust devils. “When I first gazed at some of the images from Surveyor's camera,” said Jim Garvin, NASA's chief scientist for Mars exploration, “I was moved to tears.”

**T**HE QUEST to understand the history of water on Mars has been an overarching theme in the study of the planet. Right now that quest was perhaps nowhere more concentrated than here at Malin Space Science Systems (MSSS, or sometimes “MS Cubed”), where the Surveyor camera was designed, constructed, and tested under the guidance of Edgett's boss and mentor, geomorphologist Michael Malin.

On this particular spring morning Edgett was escorting me on a virtual flying tour over Mars's surface. Exhibit A was a disheveled-looking region known as Gorgonum Chaos. Here, captured in the MGS images, we saw part of a rugged crater wall that had collapsed into a gully with a number of deep, sinuous channels fanning out, ending abruptly in an apron of deposited material.

In shape the features resembled gully washes in the American West. The flows appeared to come to a sudden halt, suggesting the material was thick—perhaps liquid filled with dirt and debris. Mud on Mars? But what really brought up the goose bumps was the panoramic repetition of the startling features. As the flight

continued along a strip of the planet's surface, the flow patterns showed up on the cliff walls and escarpments of other craters, mesas, and troughs, always erupting near their tops, always apparently from the same geologic layer 100 to 500 meters down.

The evidence disturbed the scientists in more than one respect. First, conditions on Mars are such that any water reaching the surface supposedly would not remain liquid for very long but would boil, freeze, or poof into vapor. Second, from the absence of craters, sand dunes, or anything else on top of the gullies, they appeared to have formed very recently, possibly as recently as yesterday.

By this time the signature of weeping or seeping liquid had shown up in some 200 Surveyor images. Most of the evidence was found, strikingly, in some of the coldest places on the surface—on shadowed slopes facing the poles, in clusters scattered around latitudes higher than 30 degrees—rather than at the warmer equatorial latitudes. This suggested that the flows contained frozen volatiles, substances that would vaporize if exposed to the warmth of sunlight.

Malin and Edgett had been puzzling over these images for more than a year, trying to come up with an explanation that would point to something other than liquid water before publishing their discovery. “We were dragged kicking and screaming to this conclusion,” Edgett said. But they could find no plausible “dry” explanation. And proposals for other substances that might behave as liquids on the Martian surface raised so many other questions that they failed to solve the problem.

As if this mystery weren't enough, Malin and Edgett were pondering other images that told a separate and possibly more fundamental tale of ancient water on Mars. Soon after Surveyor's arrival there, the researchers noticed images of Valles Marineris (a great canyon system that would span the continental United States) that show the planet's upper crust is dramatically layered: light, dark, light, dark. Something like what you see in Arizona and Utah at Zion, Bryce, or the Grand Canyon.

Bruce Murray of Caltech, an old friend and adviser of Malin who stopped by MSSS around



## Mars Global Surveyor

Orbiting 240 miles above Mars since 1997, Surveyor completed mapping the planet in January 2001. It's expected to collect data for at least one more year.

ART BY JOHN ANDERSON



## Scientists were emboldened to ask the big

Christmas 1997, happened to see the first images of the layering. "I can't believe it!" he said.

"Everything we knew from Mariner 9 and Viking led us to expect that the uppermost subsurface of Mars would resemble that of the moon," Malin said. "To see hundreds of individual layers defied the common wisdom."

As Surveyor's orbiting camera zoomed in, there were more surprises in the details. The presence of the layers and the way they are interbedded with ancient craters suggest that here is a priceless record of a Martian history previously unknown. The layers speak of the Mars that existed before the one that humans have observed for hundreds of years.

"The surface of today represents the preserved end of a time," Malin said. The layering "certainly preserves a story about Mars few had ever thought of before."

Actually Malin, 50, had been fretting about this issue for decades and even predicted elements of the hypothesis in his thesis written in 1975, based on Mariner 9 data, with its thousand times poorer resolution. "Nobody bought my story," he said, "so I stopped harping on it."

Until now. "If I had to bet, I probably would say these layers represent lakes that occurred on Mars very, very early in its history. I probably would say that Mars had lakes all over its surface at one time, and materials were being transported into these lakes." Just as with the

eerie signs of seepage elsewhere, the layering evidence introduces more riddles to be solved. But, says Malin, "it all points to a Mars that was substantially more dynamic in terms of its environment, weathering, erosion, and transport than anything we see on the surface today."

Perhaps the layers in the Surveyor images represent the only record of the erosion of landscapes long gone because the processes that created them no longer operate on Mars. "Craters the size of Washington, D.C., were completely filled and then exhumed," says Edgett. "Unbelievable amounts of material were moved around in ways that just don't add up."

**T**HE HUMAN PERSPECTIVE ON Mars has flickered over the centuries, but in some sense it has always centered on water. Percival Lowell's famous notebooks—drawn from telescope observations enhanced by a hopeful imagination—proposed in the late 1800s that vast, engineered canals, or irrigation ditches, carried water from the Martian poles to a mighty civilization concentrated nearer the equator, where the Martian climate was no less comfortable than, say, "the South of England."

A more skeptical assessment by Alfred Russel Wallace in 1907 described a much colder, perpetually frozen place as dead and forbidding as Earth's moon. Still, life-giving waters



flowed compellingly through the Mars novels of Edgar Rice Burroughs, while H. G. Wells conjured a Martian race of “intellects vast and cool and unsympathetic.”

Our first space-age close-up—a glimpse from Mariner 4 as it swept over a slice of ancient cratered terrain—revealed a staggeringly inhospitable world. The view brightened again with Mariner 9, the first Mars orbiter. Though it could see no features smaller than a few football fields, its images suggested a more interesting, changeable world: one where water had indeed once flowed, where the polar caps had ice in them and expanded and retreated as the seasons changed, where there was water in clouds that drifted through Martian skies.

With the ambitious Viking missions of the 1970s, scientists were emboldened to ask the

## question: Is there life?

big question: Is there life? Were there organics in the surface soil? At least for that place and time, the answer came back No.

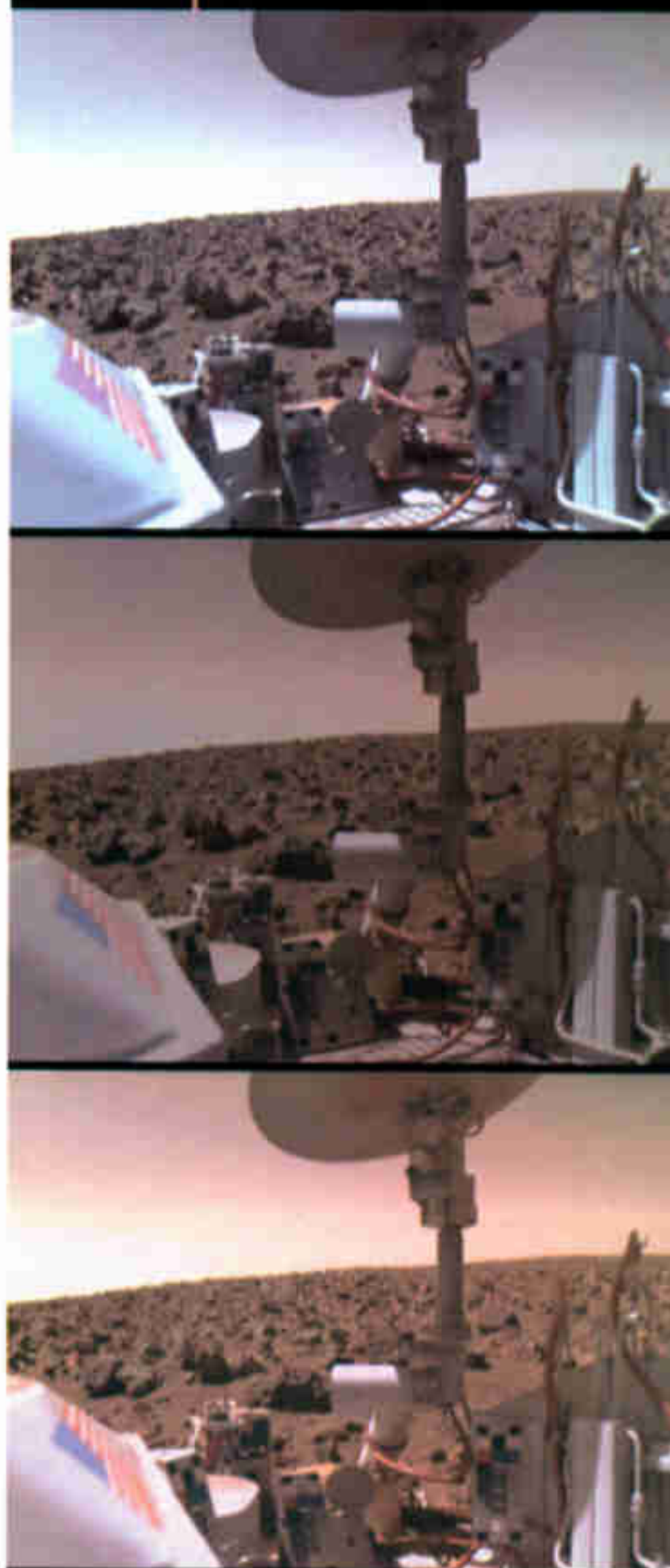
Meanwhile, scientists studying life on their home planet were gaining a new perspective on the topic. Evidence was turning up all over the globe that microbial life thrived under extremes of pressure, temperature, and other conditions previously considered lethal. Certain organisms could use chemical energy in place of sunlight.

In 1996 the startling claim that signs of possible microbial life had been discovered in a Martian meteorite helped complete the link between the Earth microbes known as extremophiles (lovers of extremes) and the hunt for life on other worlds. Although most of the scientific community rejected the more dramatic interpretations by the NASA-Stanford team, some features of the rock remain mysterious, and there is little dispute that its evidence confirms the presence of certain kinds of organic molecules on or within Mars. At the same time the intriguing complexity found within the Martian meteorite has made scientists painfully aware that they might not be able to recognize extraterrestrial life, or agree about it, if they found it.

The quest to understand the history of water on Mars not only guides scientists but also serves as an organizing *(Continued on page 48)*

## What Color Is Mars?

**SEEN FROM EARTH,** Mars glows like an orange-red ember against the dark night sky. From the vantage point of the Viking 2 lander, which in 1976 took color pictures on Mars, the red planet is really more yellow and brown. An early, uncalibrated image from Viking showed an impossibly blue sky (below, top). After corrections for color (middle), the scene was tweaked with added brightness and contrast to simulate how Mars might look (bottom) to a human visitor.





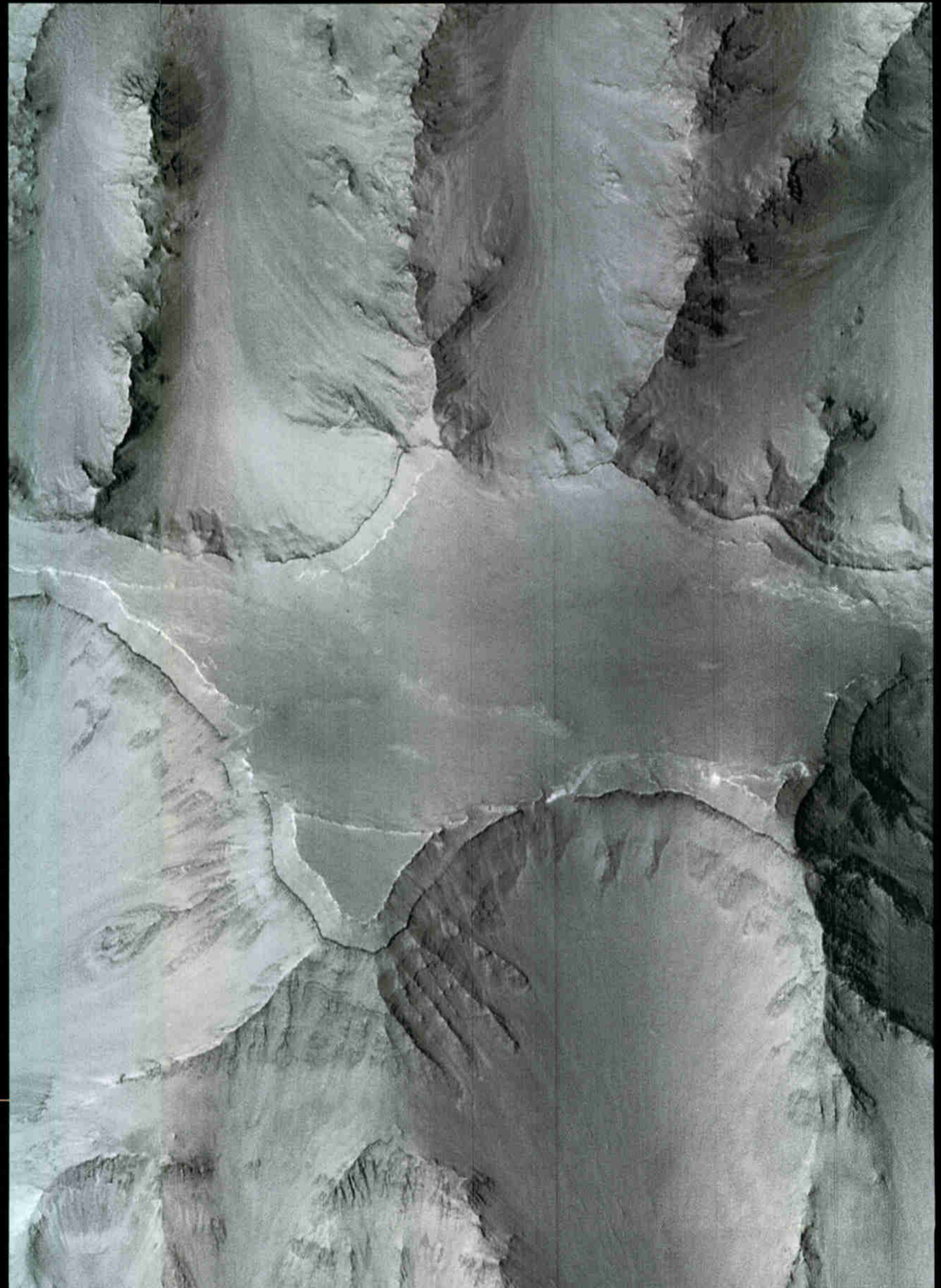
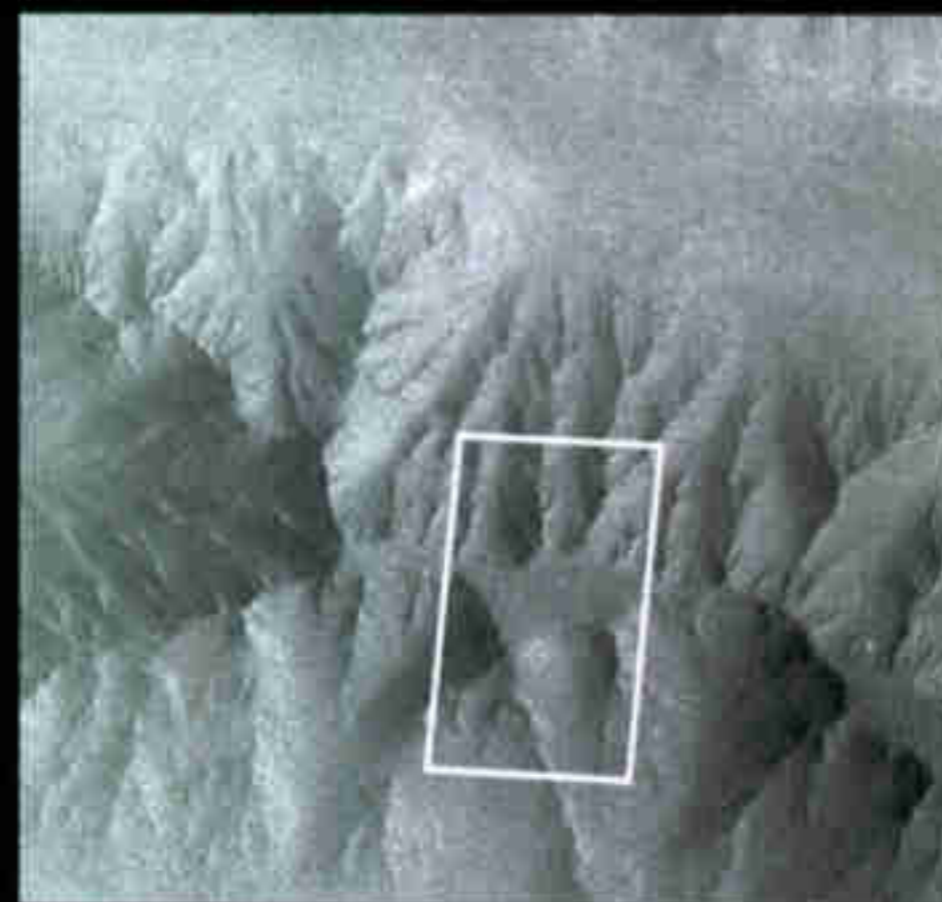
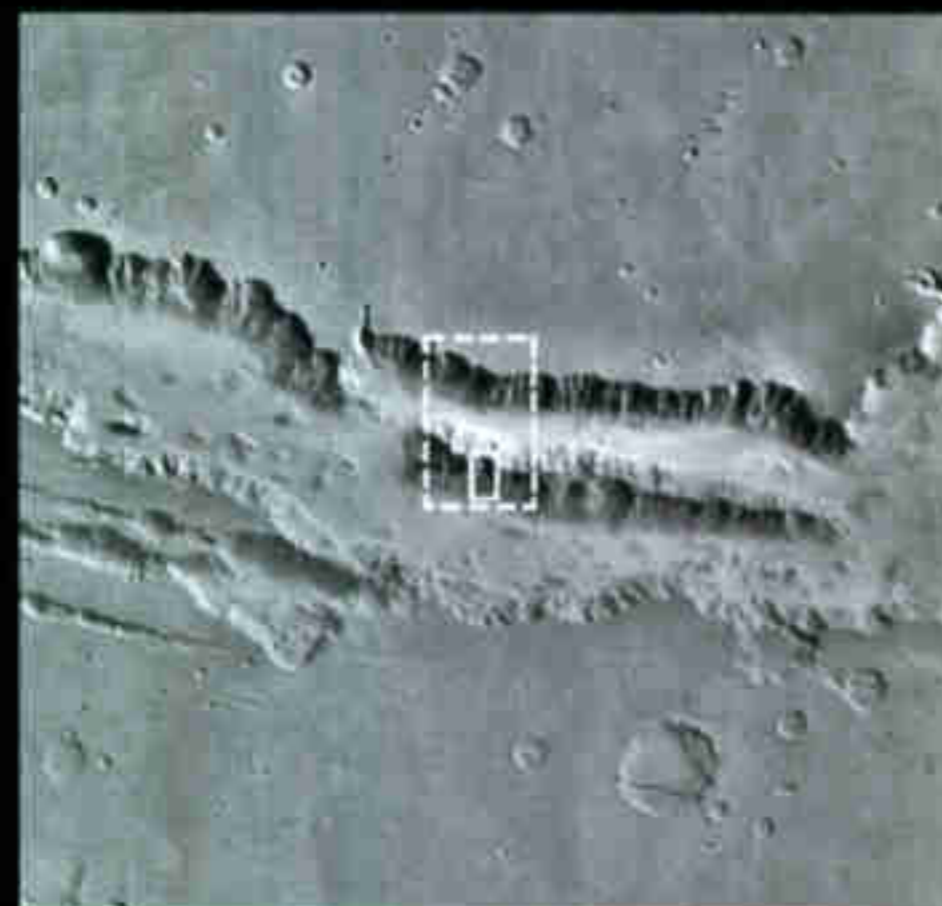
**Canyon Layers  
Preserve the  
Grains of Time.**





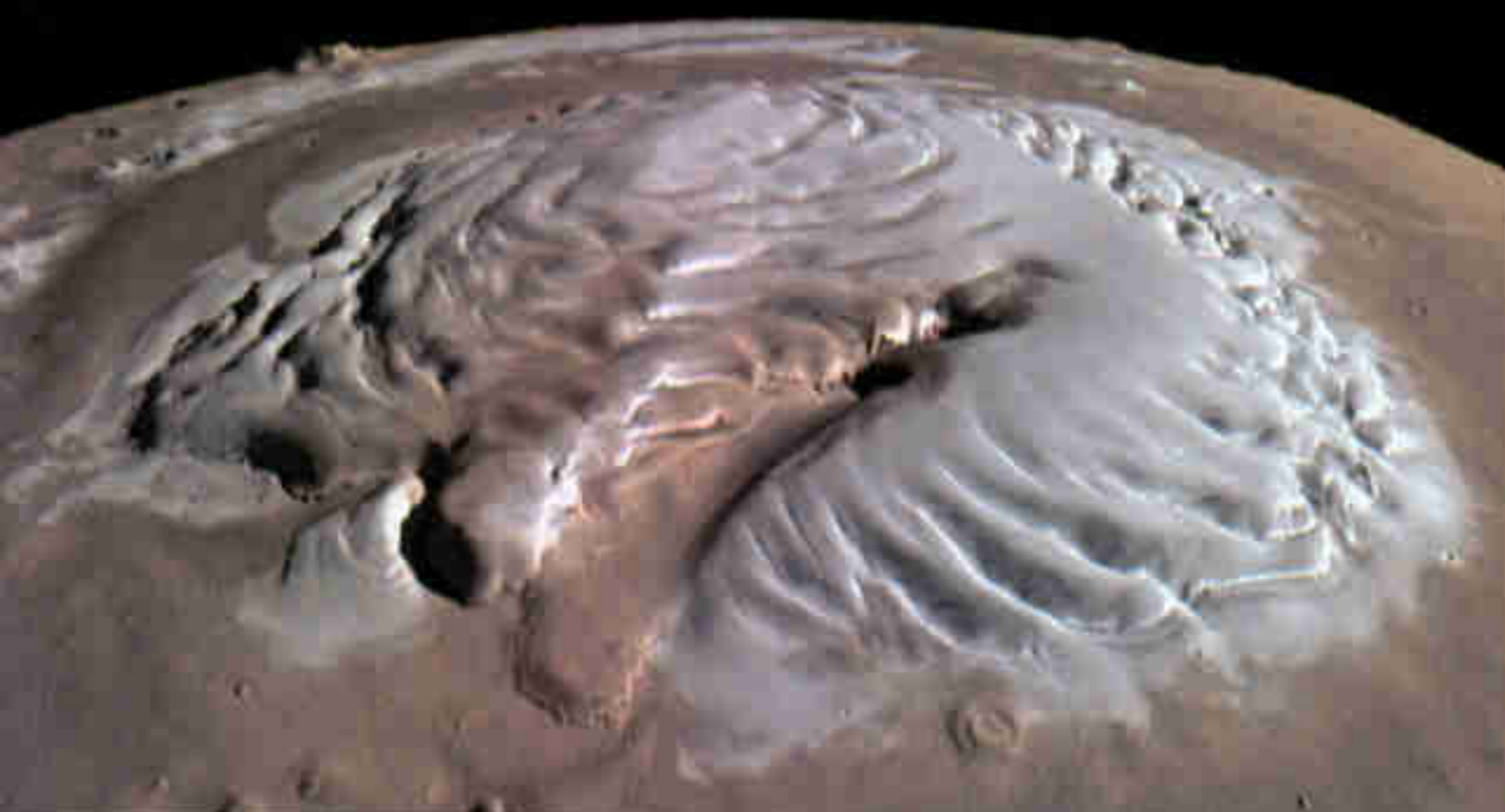
**UNMISTAKABLE** layers in canyon walls and floors in Valles Marineris record events and processes that occurred long before the present surface of Mars took shape. Repeated layers (left) on the floor of Candor Chasma (6) suggest several possible origins: voluminous floods of lava, recurring falls of airborne ash, or the settling out of material in an ancient lake. Scientists became aware of layered materials on Mars in the 1970s when the Mariner 9 and Viking missions produced detailed photographs of the Martian surface. The images surprised planetary scientists, most of whom had visualized the upper crust as a jumble of fractured and pulverized bedrock. Surveyor's close-ups expand the layering evidence, revealing Grand Canyon-like deposits that extend several miles into the troughs of Valles Marineris. Discovery of the newly seen layers, says Mike Malin, "is the most surprising result of our camera experiments—and

the most profound." Scientists dream of robots and even humans having the chance to investigate areas such as Coprates Chasma (7). Using images from Viking (below) to pinpoint a site to photograph, Surveyor's scientific team detected multiple layers on the slopes of a mesa (close-up at right), a tantalizing record of Mars's dynamic past.



## Canyon Clues



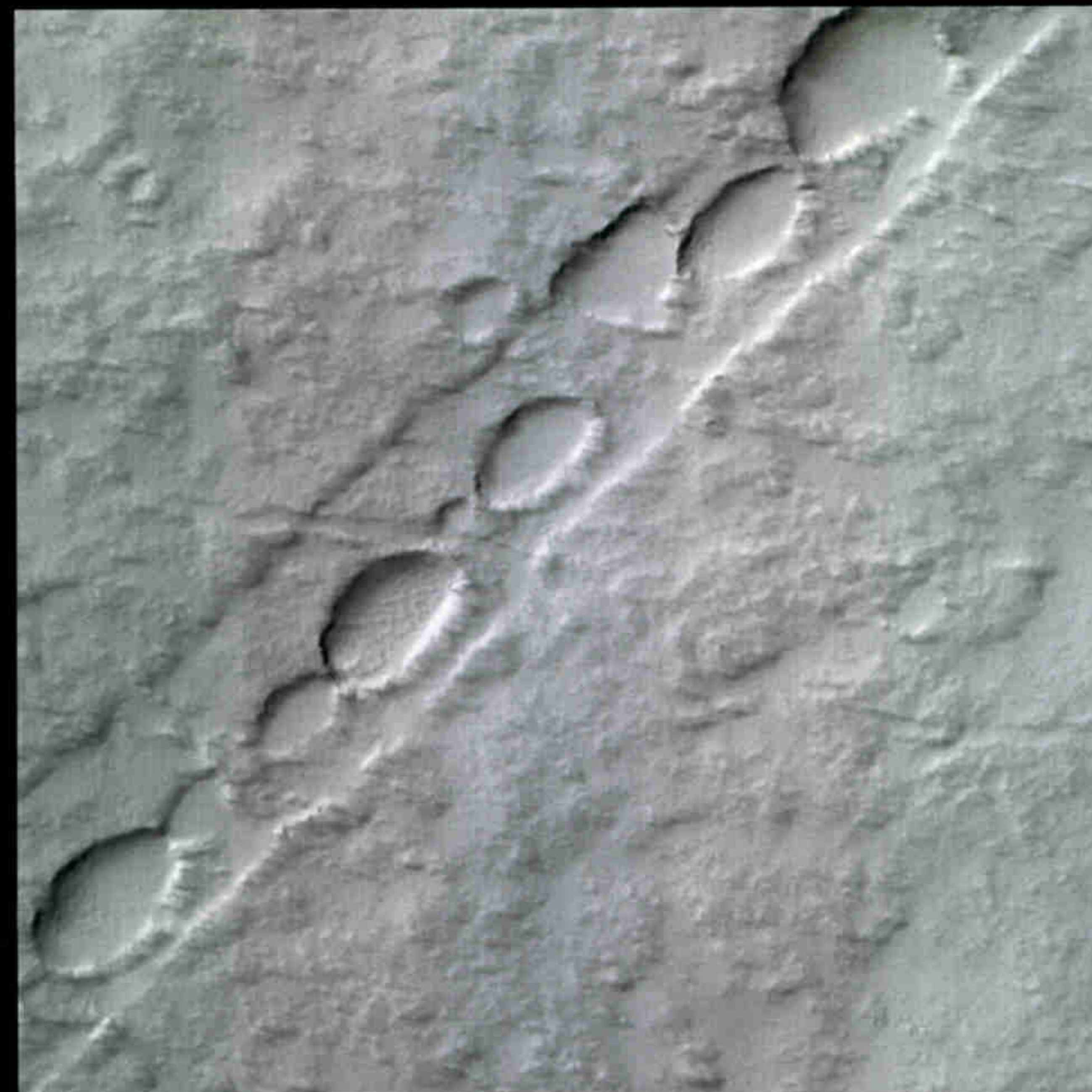
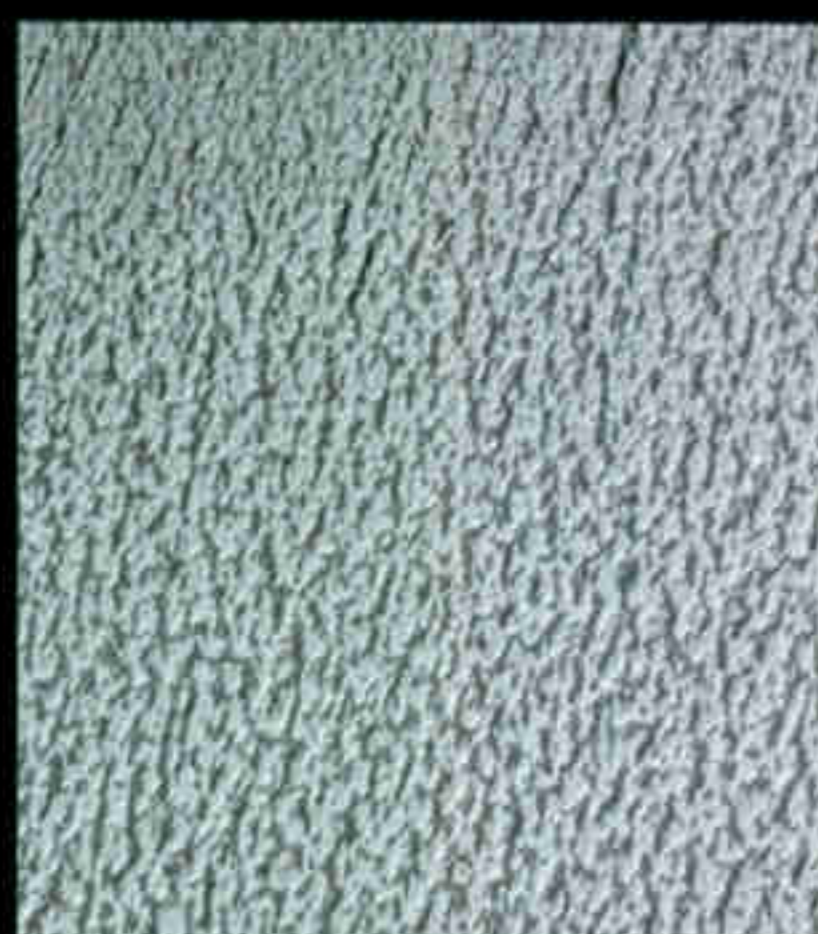
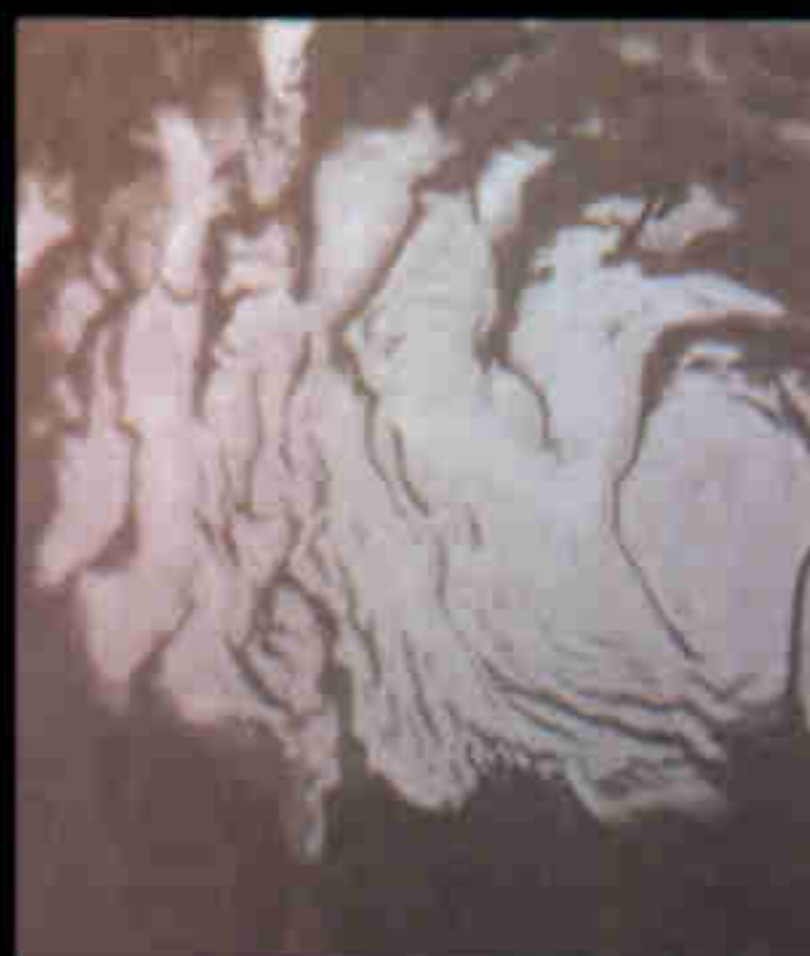


VERTICAL EXAGGERATION 25:1

**A MOUNTAIN** of ice and dust reaching as high as 1.7 miles marks the Martian north pole. Created by merging Surveyor images with altimeter data, the three-dimensional view dramatizes the pole's half-mile-deep canyons, carved by unknown processes.

## Polar Ice

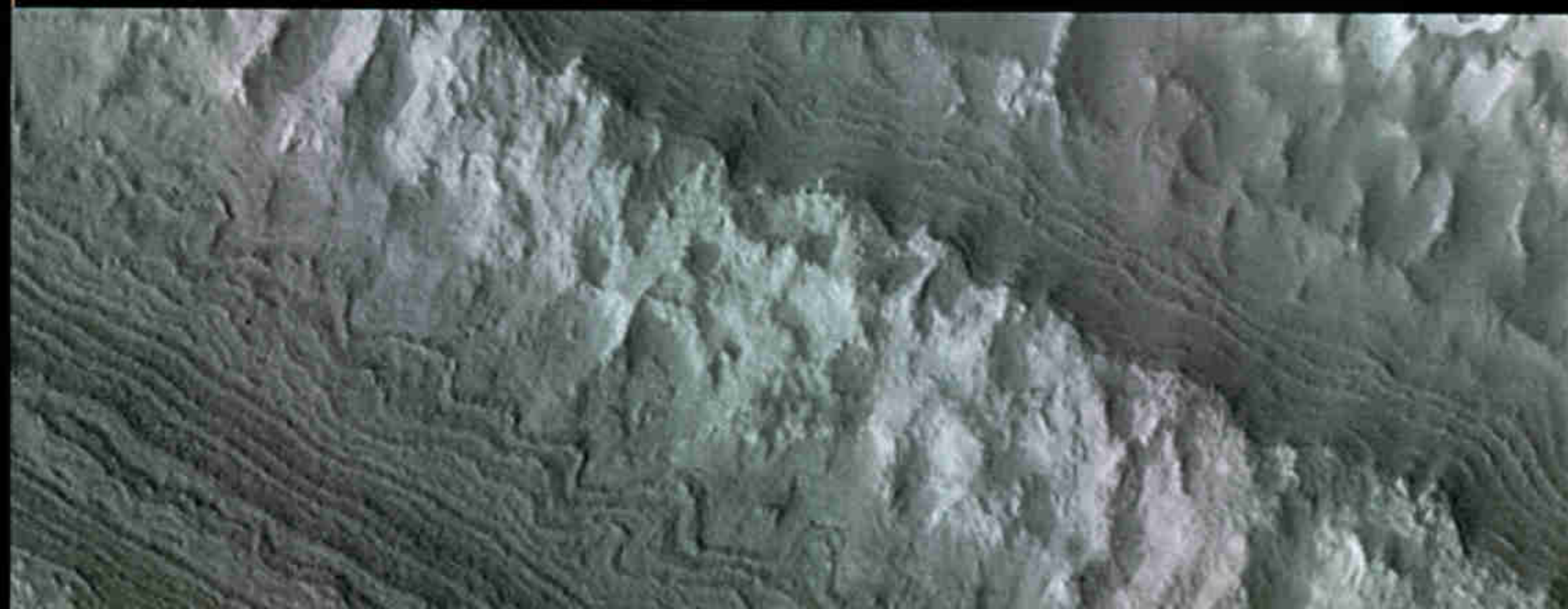
**LIKE THE EARTH'S** polar regions, the Martian poles are fundamentally different from each other, as seen here. With a diameter of 750 miles, the permanent ice cap in the north (right) is three times the size of the southern cap (far right). The northern cap is composed of water ice and dust. The surface of the colder southern cap is frozen carbon dioxide, or dry ice. The northern surface is riddled with pits (right); the southern cap (far right and below) is more complex, with large escarpments, mesas, and circular pits.



DETAIL OF PAVONIS MONS, 1.9 BY 1.9 MILES

**AN ARTFUL VIEW** from space reveals a bracelet-like chain of shallow pits lining a trough created by faulting. The collapse zone appears on a flank of the Pavonis Mons volcano (8). Some 530 yards wide, the depression could have resulted from the underground movement of molten rock. Unlike Earth, Mars has a rigid crust. Without plate tectonics, features such as linear mountain ranges and spreading ocean floors are missing on Mars.

## Faulting





**THE WORK OF DUST DEVILS,** a tangle of dark lines streaks the floor of Argyre Planitia (9), an impact basin. A common occurrence on Mars, a dust devil forms when a column of air begins spinning above sun-heated ground. The mini-tornado picks up dust as it moves, exposing the darker surface underneath. The origin of the lines was a mystery until Surveyor detected the actual shadow of a dust devil as it scratched a path. Wind also removed a coat of light-colored dust behind a crater (below), leaving a wedge in its lee.

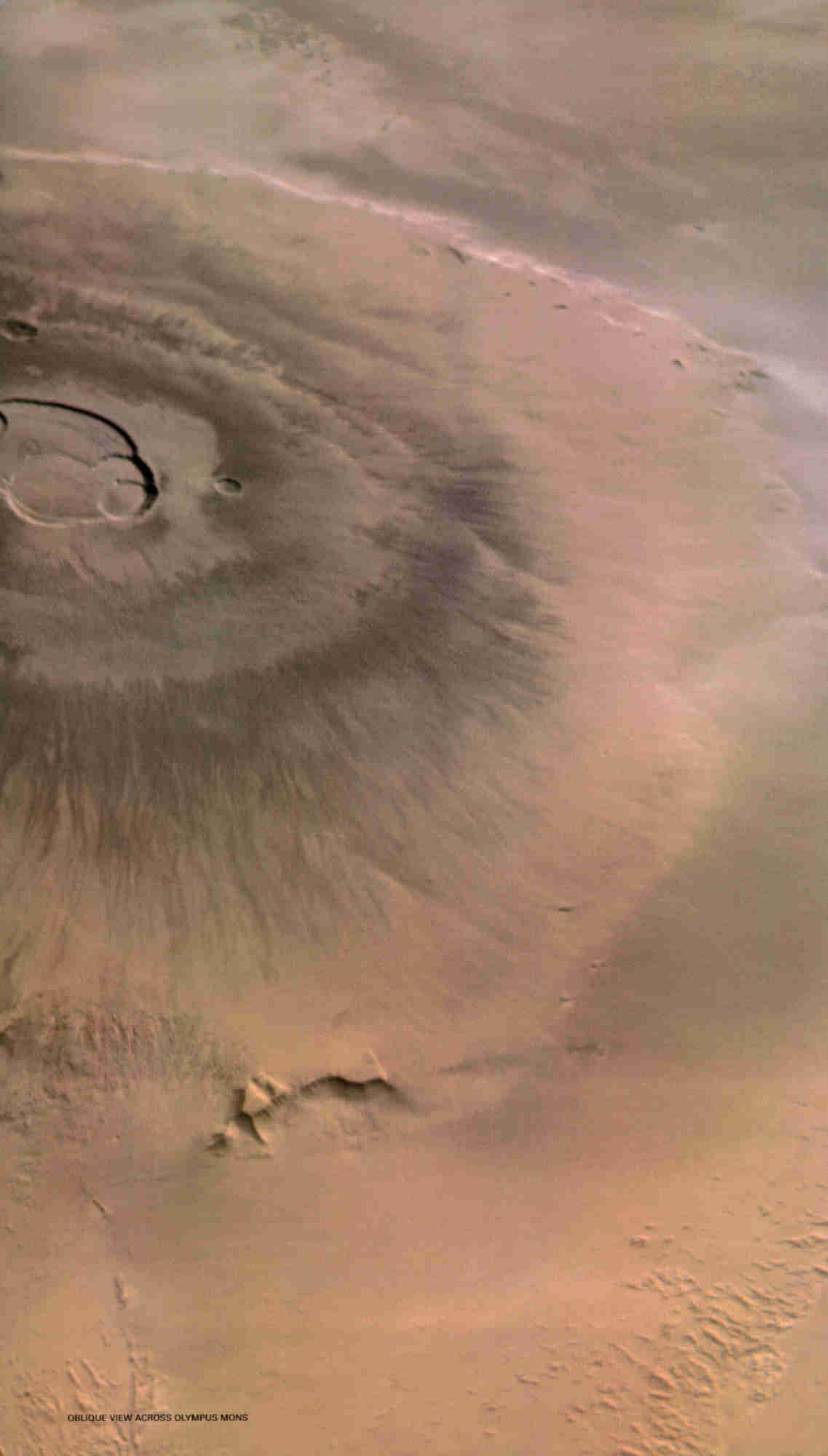


CRATER IN DAEDALIA PLANUM (LEFT), 2.7 BY 3.7 MILES; WIND TRACKS (ABOVE), 1.9 BY 3.1 MILES

SURVEYOR'S HIGH-RESOLUTION CAMERA MAKES IMAGES IN STRIPS, SUCH AS THIS 11.4-BY-1.3-MILE PASS ALONG THE SOUTHERN POLAR CAP.







OBLIQUE VIEW ACROSS OLYMPUS MONS



## Volcanic Activity

**LARGEST VOLCANO** in the solar system, Olympus Mons (10) rises some 13 miles above its surroundings (left). By contrast, Earth's largest volcano, Mauna Loa in Hawaii, juts 5.5 miles from the ocean floor. Volcanoes grow to giant size on Mars because in the absence of moving crustal plates they remain fixed above their magma source. Scientists think that Mars remains volcanically active. Rippled lava in Dae-dalia Planum (11) appears to have been halted by a crater rim (below, at top).



LAVA FLOW (LEFT), 1.3 BY 1.8 MILES; ERODED SURFACE (ABOVE), 0.8 BY 1 MILE

**EROSION IN ACTION**, a layer of light-colored rock is being scoured away to expose a much older crater. A period of intense meteorite bombardment ending some four billion years ago pockmarked the Martian surface. Though it remains heavily cratered, many of the depressions are buried beneath lava or dust. Experts believe wind erosion exhumed this crater.

## Impact Craters



(Continued from page 39) principle for NASA's long-range Mars exploration plan. Liquid water is essential for all known biology, and scientists note that everywhere life is found on Earth, it exists in combination with organic material, an energy source, and liquid water. If the Malin-Edgett seepages do represent water, says Edward Weiler, NASA's associate administrator for space science, "It could have profound implications for the ultimate question: Are we alone?"

But biology takes time. For three decades planetary scientists have debated a fundamental question about Mars: Did it rain? The answer is crucial, many believe, to the ease with which life could arise there, at least at the surface. Rain implies a warmer climate, where water could flow or pool for long periods, a water cycle persistent enough for life to have developed. The geologic record has suggested that Mars was warmer, wetter, and more Earth-like billions of years ago—possibly back to the very time that life was emerging on Earth. There is abundant evidence that water in huge quantities once flowed there, but then something changed on Mars, leaving its surface barren, cold, dry, and desolate.

For some 30 years the primary evidence for a wetter, warmer early Mars has been the many branching channels, known as valley networks, that some believe were carved by cascading rainwater. Because they occur on heavily cratered terrain, the assumption was that they are

much greater than it was," says Arden Albee, Surveyor project scientist at the Jet Propulsion Laboratory (JPL) in Pasadena, which manages the Mars program for NASA.

One of the consistently puzzling aspects of the data so far is in the evidence of huge basins within the structure of the Martian crust. Findings from Surveyor's laser altimeter and gravity sensors, published in early 2000, revealed signs of buried channels that could have been carved by floods of water flowing from the southern highlands into the northern lowlands billions of years ago. Once on the surface but since buried in sediment, these channels are as much as 125 miles wide and more than a thousand miles long. They hint at the existence of oceans. A depression near the north polar cap looks the way the site of an ancient ocean could look on Earth.

But intensive searches for confirming details, such as a shoreline, have turned up nothing conclusive. (Although geomorphologist Tim Parker of JPL has argued persistently that such details are there.) And scientists can't tell yet whether the basin's flat bottom represents sediment that settled out, which would also be a key indicator of oceans. One of the more intriguing ideas under debate is the possibility that the water flows were ice covered.

The data also have some scientists rethinking their techniques for determining the age of features on Mars (counting craters and the

## "In fact, many Mars features don't look like

very ancient and the valleys carved among them are very ancient.

Other Surveyor data have been more consistent with a "no rain" scenario, suggesting negative implications for life on the surface. What if the streambeds and channels seen on Mars were created in brief, spasmodic events—such as molten volcanic flows or explosive asteroid and comet impacts—that cooked the surface and melted the ice? If so, some argue, it is unlikely that there was a climate temperate enough for rain to fall and unlikely that water was present on the surface long enough for life to have begun there. Also, Surveyor images show branching channels ending abruptly in box canyons, which indicate flooding rather than rain. "The evidence against rainfall is

like), where the uncertainties of chronology are already vast. They also see problems in some cases with their practice of basing assessments of Mars geology on features similar to those they've studied on Earth.

"Now that we have the data from MGS, we know much more about Mars's surface features, and we find that few field sites on Earth are good analogues. In fact, many Mars features don't look like anything on Earth," said Dan McCleese, chief scientist of the Mars program at JPL. Even in the case of Malin and Edgett's gully-like seepages, he notes, the Mars versions are sometimes way off scale, much larger than their best counterparts on Earth. "The absence of an Earth analogue for these at the right scale," he adds, "has been a problem."



Another jarring turn in the data comes from the Thermal Emission Spectrometer, which has been searching for certain minerals that are formed over long periods in the presence of water, usually warm water. Contrary to expectations only one such mineral, gray crystalline hematite, has been detected, and in only two places. And even this case is inconclusive, since hematite can be formed without water. Scientists plan to look again with higher resolution instruments.

But for now, it seems, the conviction that there was a wet, warm Mars a long time ago has been shaken. Where there is evidence that water once flowed, scientists don't understand what processes drove it.

Veterans of Mars exploration have felt their enthusiasm increasingly tempered of late by a renewed sense of respect, even humility, regarding the planet. There is of course the pain and shock of losing an orbiter, a lander, and two microprobes in rapid succession in late 1999 and the awareness that of the 30 Mars missions launched by the United States or the former Soviet Union to date, 21 have failed completely or partly. And of 12 attempts at landings, only four have made it.

Even more daunting is the new appreciation arising from the Surveyor data of how poorly the planet is understood and how ill-equipped scientists and engineers are to confront it.

All these factors informed NASA's drastic

## anything on Earth."

alteration last year in its strategic approach to Mars, which had been driving toward the goal of bringing back samples gathered from the Martian surface for study in sophisticated Earth labs, in hopes of finding evidence of past or present biology. "With the evidence we have now," JPL's McCleese said, "our problem is that we don't know where to land."

After a period of lively debate, NASA last October announced the outlines of a long-term strategy designed to be less vulnerable to failures and better able to respond to new discoveries and evolving scientific understanding of the planet. "You have to assume Mars will continue to surprise us," Edward Weiler said.

Two spacecraft equipped to pursue signs of water on and below the Martian surface—the

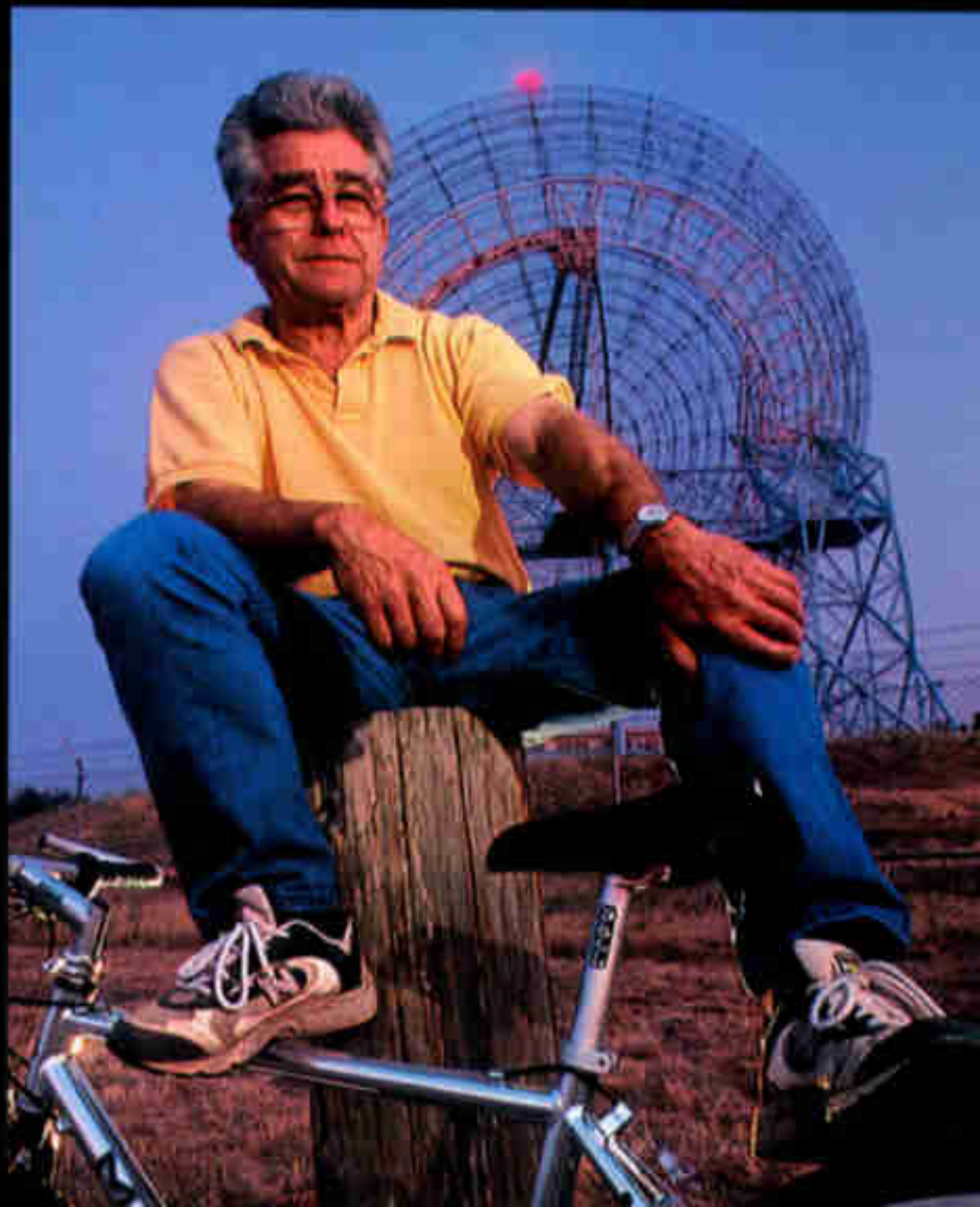
MARS



BOTH BY JAMES A. SUGAR

**AT HOME WITH MARS,** Mike Malin (above, at left) and Ken Edgett of Malin Space Science Systems review a few of the 80,000 images sent back by Surveyor. Camera designer Malin says, "Until now the smallest thing resolved in the Mars images was the size of three football fields. Now it's more like three football players."

Mars expert Michael Carr (below) of the U.S. Geological Survey in Menlo Park, California, urges caution about interpretations: "Conditions on Mars are very, very different."



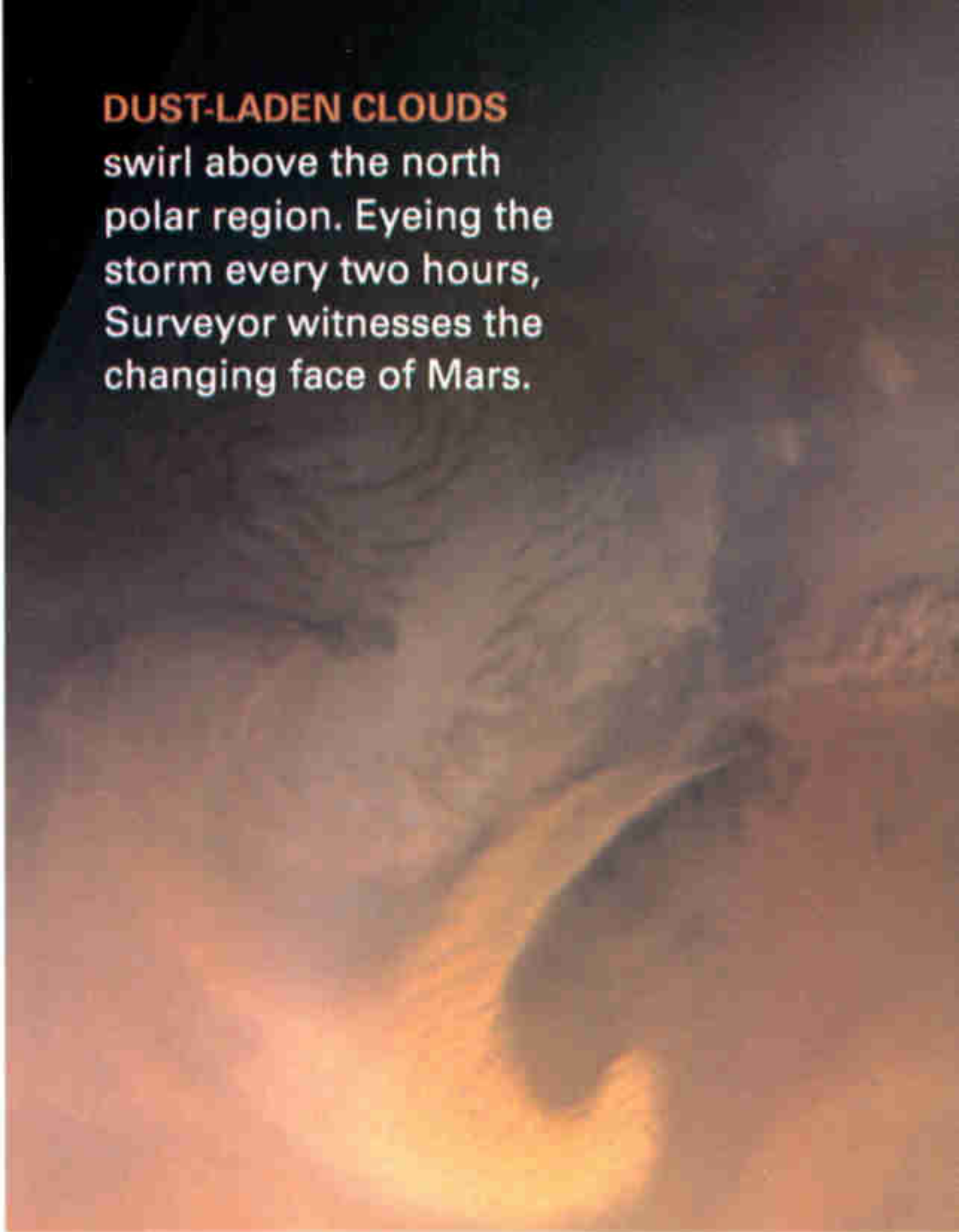


U.S. 2001 Mars Odyssey and the European Mars Express—were already on track for launch this year and in 2003 respectively. In addition, Weiler has decided to send two robotic rovers to the planet's surface in 2003, each a much more capable "geologist" than the experimental Pathfinder model.

Beyond that, missions later in the decade will depend on what the 2001 and 2003 explorations reveal about Martian climate and geology and how the technologies advance. Tentative plans call for the 2005 launch of the Mars Reconnaissance Orbiter, a craft that could photograph surface details as small as beach balls and follow up on the mystifying hints of water seen in the Surveyor images. NASA also envisions a new generation of smart robots that could land with greater precision and explore as much as a hundred miles of terrain, avoiding hazards while doing so. While past landings have been aimed at relatively bland, safe spots, the

#### DUST-LADEN CLOUDS

swirl above the north polar region. Eyeing the storm every two hours, Surveyor witnesses the changing face of Mars.



## When you have the only camera on Mars, the

evidence is urging the explorers toward some of the most treacherous, cliff-covered badlands on the planet.

Bringing home samples of Martian rocks and soil is still a goal, Weiler emphasized, but not until at least 2011. To make sure such a costly mission (an estimated one to two billion dollars) goes to the right place on Mars, the exploration leading up to it will focus on determining whether the ingredients required for life—liquid water, complex organic molecules, and a source of energy—ever existed together anywhere on Mars and, if so, where.

The space agency has already begun developing better technologies for the eventual return of samples: improved methods for preserving them on the trip home, for detecting life, for preventing contamination of Earth's biosphere should there be any captured microbes in the trove, and for analyzing the rocks once they are in hand.

Planetary exploration is inherently risky, but the avoidable 1999 failures convinced managers that, among other problems, the philosophy known as "faster, cheaper, better" had been pushed too far toward faster and cheaper. With little additional money in their exploration

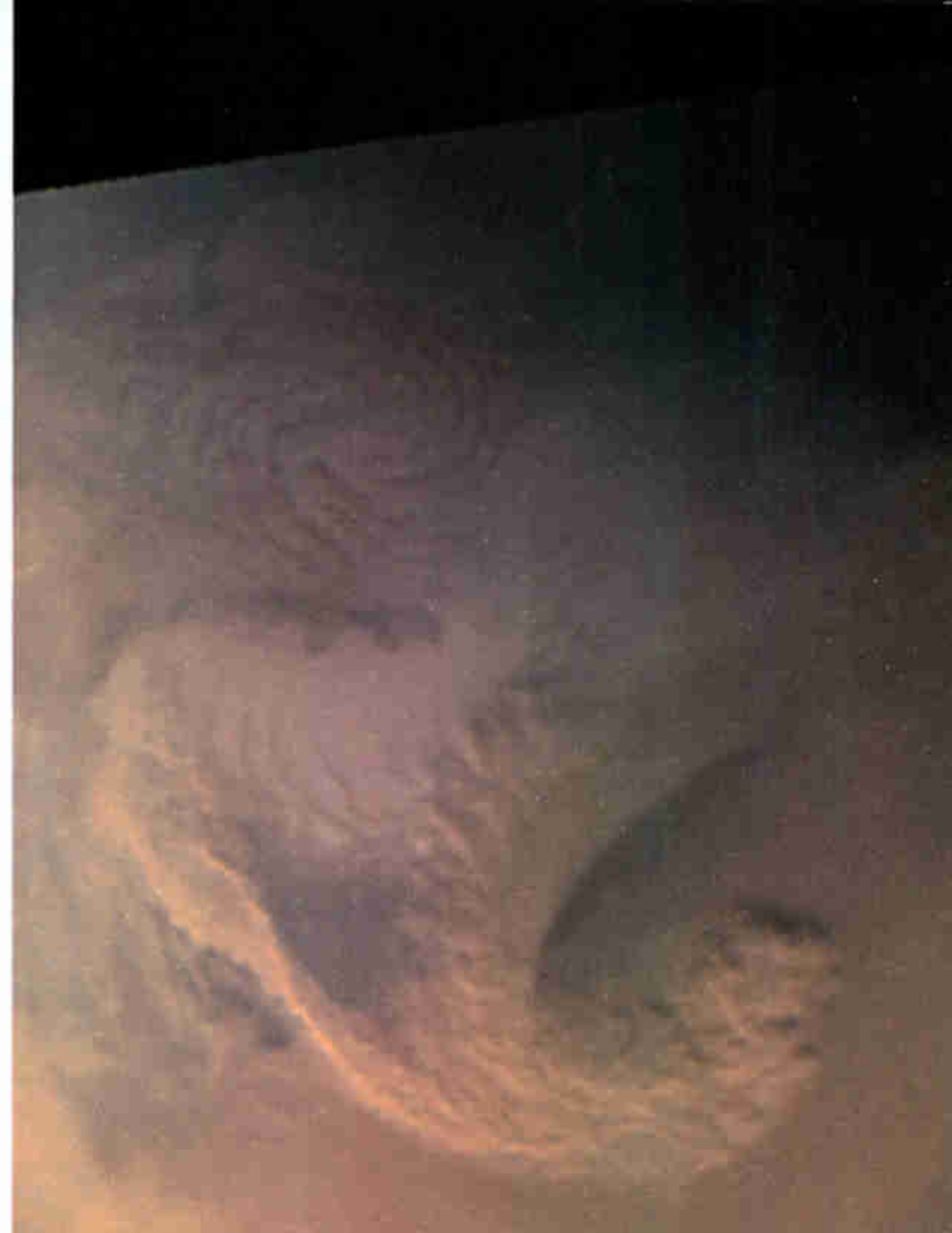
budget, program leaders plan to reduce the chance of failure in part by stretching the mission schedule over longer periods.

**T**HROUGH THEIR CAMERA, the Malin team will tell you, they live the Surveyor mission with a dailiness hard to explain to the outside world. They experience the Martian seasons, watch the polar caps shrink and expand. They take their vacations once each Martian year (every two Earth years) when Mars is on the opposite side of the sun from the Earth.

And they have learned that when you have the only camera on Mars, the pressure can get intense. Malin and his beleaguered staff of ten struggle constantly to cope with the sheer volume of incoming data. When I visited MSSS, machines from the entertainment industry used to mass-produce CDs were cranking out discs like pancakes, leaving them stacked up everywhere in the lab. It took 44 CDs to contain just the first six months of Surveyor data, and scientists around the world had been clamoring impatiently for copies.

I arrived one morning to find Edgett at a computer, where he'd been since about





## pressure can get intense.

5:30 a.m. camera-targeting—planning out the sequence of images to be taken three days hence. Using a mouse, he clicked on some instructions on his screen and shifted the position of a small white box superimposed on the Martian surface to a spot along the spacecraft's predicted ground track for that day.

At peak data-transmission rates, the camera takes 300 pictures a day, and a mere 60 during slower periods when Mars is farthest from Earth. At full throttle, when the two planets are closest together, Edgett can spend 12 hours planning 24 hours of observations.

This is an obscure field of expertise with just the one leading practitioner, who has much of the “mission memory” stored in his brain. Despite long lists of previously identified targets, Edgett notes that many of what have turned out to be the most surprising and informative sites—such as those showing seepage—were products of serendipity. “You don’t have a roomful of engineers and scientists making decisions,” said Edgett. “The target list is due in six hours, and I’ve got to get it done. The ability to learn as we go, to select what we shoot,

that’s what makes for a powerful mission.”

But as Malin and Edgett pondered those elusive landscapes, they admitted to a certain melancholy. “We are constantly aggravated by the fact that all the questions we have about Mars could now be answered by Ken and me if we could just walk around on the planet for a few days,” Malin said.

Edgett agreed: “It’s unusual to hear people like us argue for manned space exploration. But for about two years now Malin and I have been absolutely convinced that we’re going to have to send people there.”

Short of digging with his own trowel into the Martian sand, Malin has his heart set on dispatching a sophisticated Mars airplane, built by a consortium of Earth’s best high-altitude aircraft experts. He can almost see it—soaring on its ten-meter wingspan on a three-hour tour over the eastern region of Valles Marineris to study the layering or to Gorgonum Chaos and one other seepage site.

Its camera and remote-sensing instruments would probe the planet’s interior, and “if there’s liquid water there now, it will glint like gangbusters at radio frequencies.

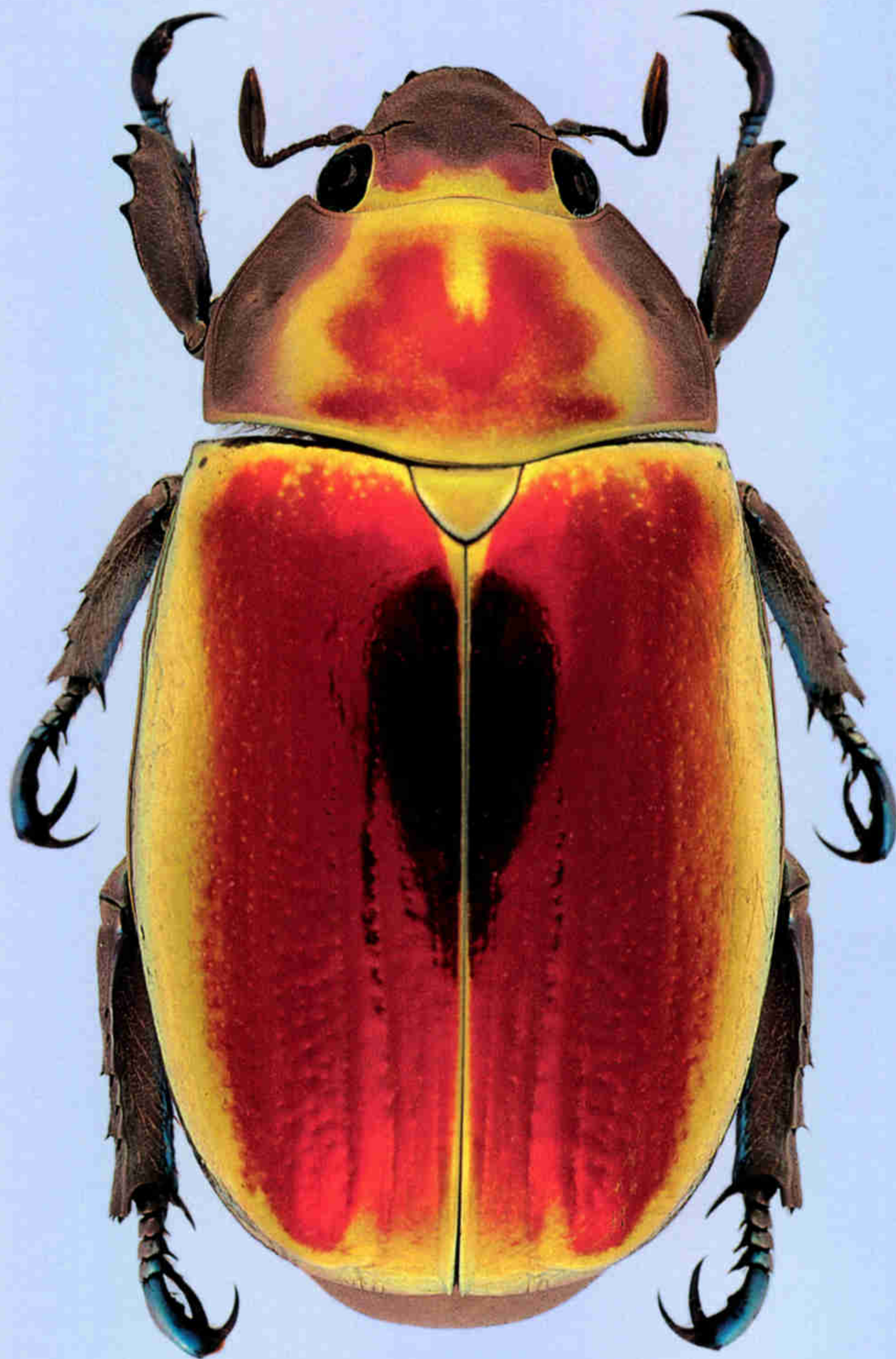
“I would give them a Mars they’d never dreamed of.” □

### MORE ON OUR WEBSITE

Go to Mars: View the red planet as if you were a passenger aboard the Mars Global Surveyor at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).



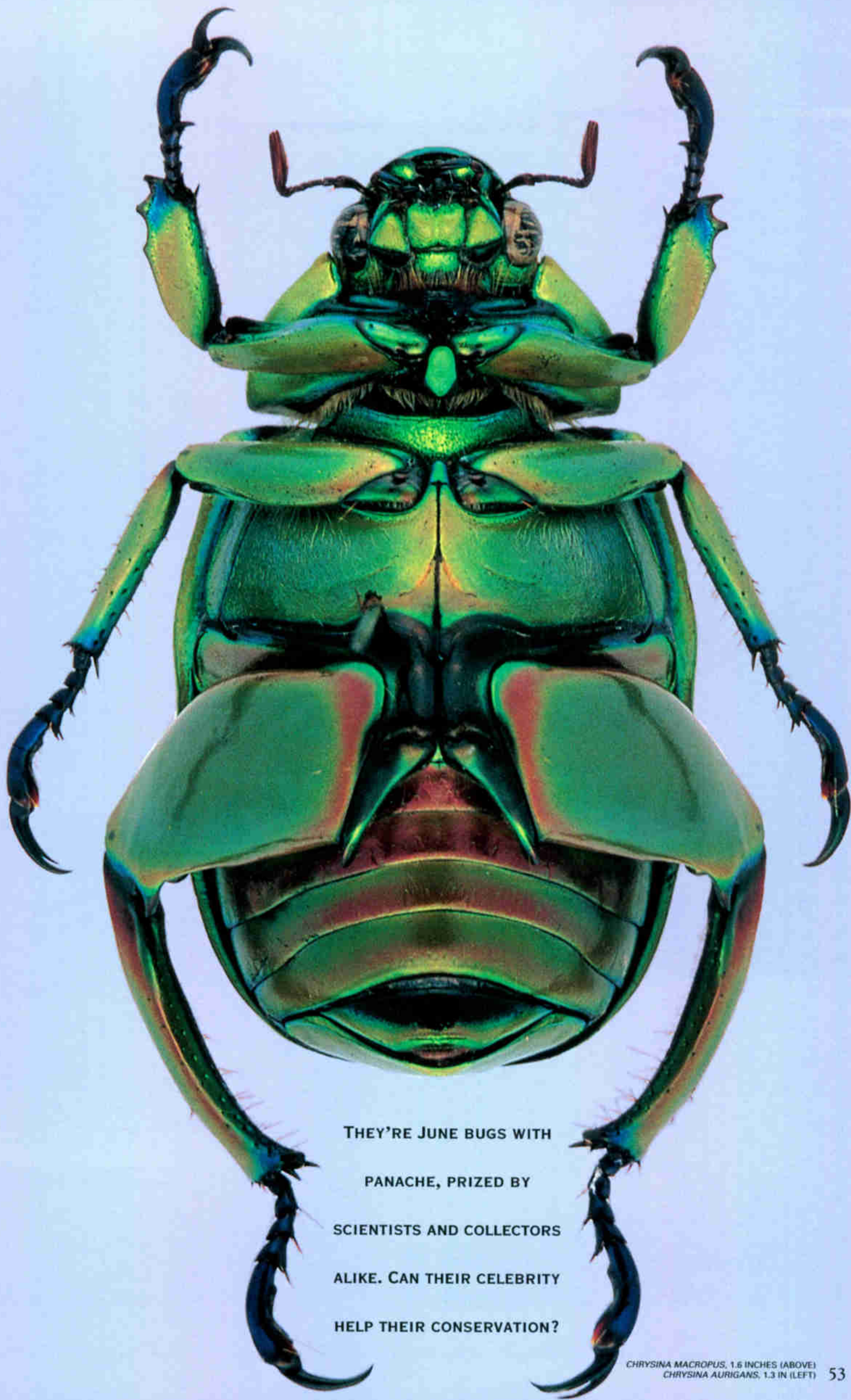
J E W E L



BY RONALD D. CAVE  
PHOTOGRAPHS BY DAVID HAWKS

S C A R A B S





THEY'RE JUNE BUGS WITH  
PANACHE, PRIZED BY  
SCIENTISTS AND COLLECTORS  
ALIKE. CAN THEIR CELEBRITY  
HELP THEIR CONSERVATION?





Some \$8,000 worth of jewel scarabs are displayed for science, not sale. Heat and humidity during





NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN

development may influence color: Some green species have a pink form and some silvers go gold.





KENNETH GARRETT

Once threatened by logging, Cusuco National Park (top) is now protected and is home to at least seven species of beetles called jewel scarabs. After three years of studies in Honduras, my collaborator David Hawks and I remain awed by the diversity in what we now regard as a single genus, *Chrysina*. Found at all our study sites (map), *C. quetzalcoatli*—seen here mating and nibbling needles—is just one of about a hundred species.

In a world among the clouds, entomologist David Hawks and I keep watch for the brilliant jewel scarabs of Honduras's tropical montane forests. We wait like fishermen with nets cast, standing beside lighted white bedsheets spread on the ground. When the jewels fly in, raining color against the cloth, we feel like kids again.

We collect jewel scarabs—to estimate their population sizes and study their ecology and distribution. Dave joined me here in 1992, bringing his passion for jewels with him. Since then we and others have found seven new species in Honduras, and we rediscovered a species once thought extinct. We've just begun to tap into these amazing populations.

Not surprisingly, scarabs have also seduced commercial collectors. While many sell for a few dollars, a bright red specimen might fetch \$200, the finest gold, \$500. With such a bounty on scarab heads, some conservationists worry that populations could be depleted by the trade. But our research suggests otherwise.

Catching insects isn't like hunting jaguars. Millions of jewel scarab eggs, larvae, and pupae remain underground, while collectors take only adults. Meanwhile, the journey to scarab habitat weeds out all but the most determined. Many cloud forests are a strenuous trek away; others require a helicopter. The biggest threat to scarabs is not insect hobbyists but loss of habitat as tropical forests are converted to farms. We believe that regulated beetle collecting by local people—and, in time, beetle farming—could actually help slow this process. It has been successful elsewhere with butterflies and other insects. If a cottage industry developed, some local people might find that a treeless patch of land is worth less in the long run than a standing forest full of jewels.

**SOCIETY GRANT**  
This Research Committee project is supported by your Society membership.



CHRYSINA QUETZALCOATLI, 1 IN (ABOVE AND RIGHT)









Jewel scarabs wear evolution's disguises well, and we relish trying to reveal them. Blanketed by a sweet gum leaf, *C. karschi* (left) clings for its life in excellent camouflage. Reflections from a stunning drop of silver (below) might confuse predators. How can we not wonder if the rear end

CHRYSINA KARSCHI, 1.2 IN

## THE ROLES OF A LIFETIME

The sleek adult jewel scarab (bottom) has modest beginnings. Beneath or inside rotting stumps and logs, females lay several dozen eggs before severing family ties. Once hatched, worm-like grubs, or larvae (curled, above right), burrow into the wood compost and feed on cellulose—which they digest with the help of symbiotic bacteria and fungi in their guts. Grubs develop for a year or more, then form chambers in the wood and transform into pupae (center).

When the rainy season begins in May, we see adult scarabs emerging, still soft-bodied and pale. Within hours, bodies harden and the jewels show their true, often splendid colors. We estimate that these scarabs live for as many as three months in the forest canopy, feeding on leaves, reproducing . . . and hiding.



CHRYSINA PASTORI (ALL STAGES)





of an as yet unnamed *Chrysina* (right) evolved the grimace of a tree frog to keep hungry birds at bay? Many tropical frogs exude toxins—and birds know to avoid them. “There may be mimicry going on here,” says Dave. “It’s just an idea, but one that would be fascinating to investigate.”



CHRYISINA SP., 1 IN (ABOVE); CHRYISINA LIMBATA, 1 IN, GUY BRUYEA (BELOW)







CHRYSIONA CUSUQUENSIS, 1 IN (ABOVE); CHRYSIONA CAVEI, 1.3 IN

## NIGHT FLIERS COME TO LIGHT

**New finds:** Believed to be endemic to a single tropical forest in Cusuco, *C. cusuquensis* (above) lives among the clouds above 6,000 feet. Access to its remote habitat is over tortuous roads and lung-busting trails. That's true also of *C. cavei* (right), a new species that Dave kindly named after me. The male uses its reddish orange and blue hind legs to battle rival males for mates. Inattentive



human hands get the same treatment from needle-sharp spurs and claws. Sharing its name is an honor, but getting pricked by *C. cavei* keeps you humble.

Crouching beside a mercury-vapor lamp amid wildly dancing moths (right), I take a turn collecting the nocturnal *Chrysina* from among the riot of fliers.



When the metallic scarabs come into the light, it's as if the stars are falling from the sky—and local people sometimes sit and watch the show. In a scientific Morse code, we mark the beetles' wing covers with tiny pinholes to indicate date and location of capture. "Some nights we see repeats, but

often we get a whole new cohort of insects," says Dave. "It's truly remarkable."

The next day, a marked *C. spectabilis* lightens its load in the hand that frees it (left)—a movement observed before almost every takeoff. As we continue to study the behavior and range of these winged jewels, we will look for ways they can be harvested from the wild and farmed to help support forest conservation. But on tropical nights, scarabs in flight take on a value for us that goes well beyond what any market will bear. □



CHRYSINA SPECTABILIS, 1.5 IN

**MORE ON OUR WEBSITE**

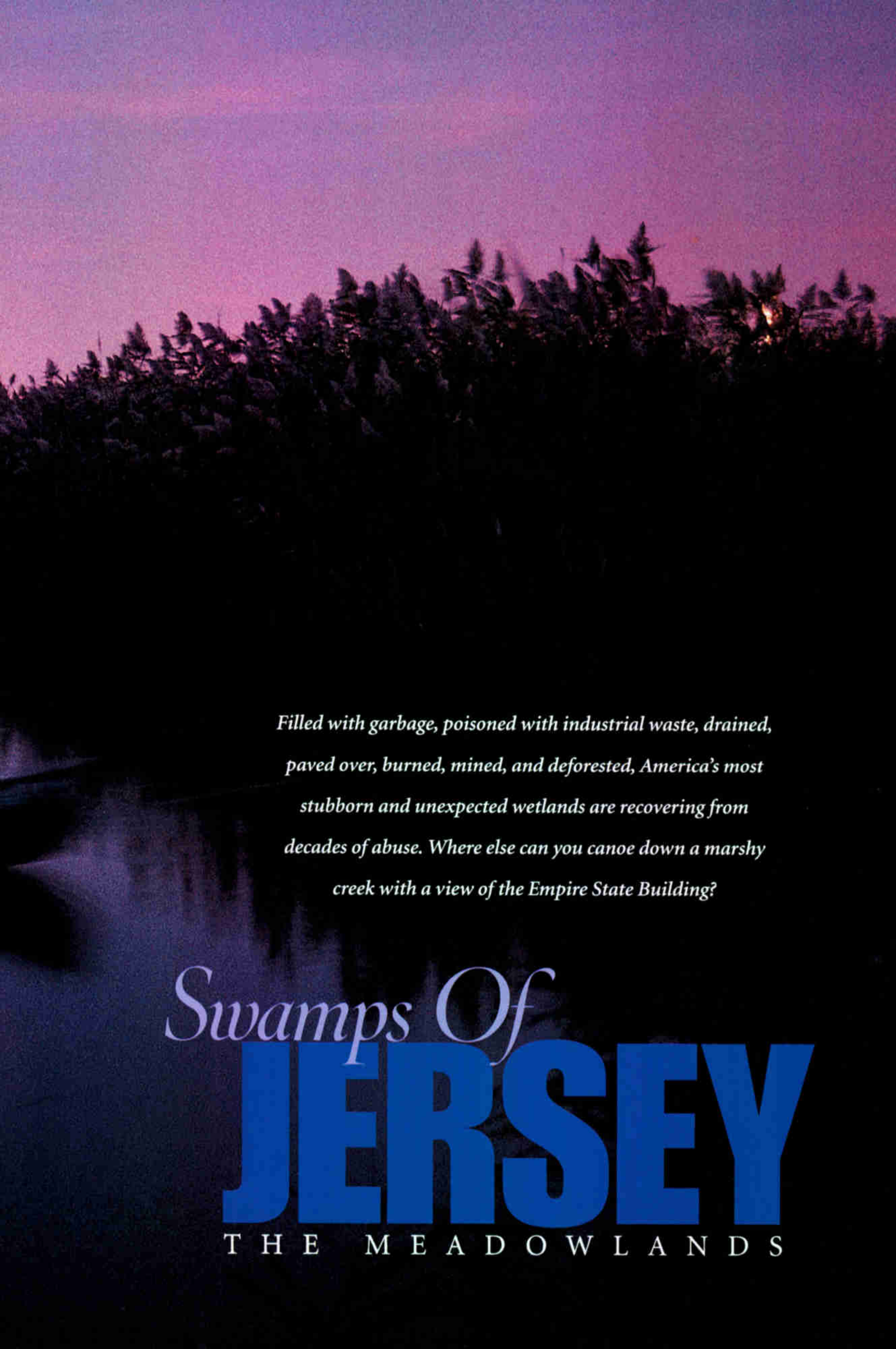
See more photographs of jewel scarabs and find related websites and other resources in More to Explore at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).











*Filled with garbage, poisoned with industrial waste, drained, paved over, burned, mined, and deforested, America's most stubborn and unexpected wetlands are recovering from decades of abuse. Where else can you canoe down a marshy creek with a view of the Empire State Building?*

*Swamps Of*  
**JERSEY**  
THE MEADOWLANDS



By RICHARD CONNIFF

Photographs by MELISSA FARLOW

**I**N THE STRANGE TERRITORY called the Meadowlands, just west of Manhattan, a battered volcanic knob of rock juts up from the mudflats and reed thickets. Its history, like its name, is colorful. Snake Hill was once home to the indigent and the insane, and prisoners in the county jail here broke up the rock with sledgehammers. Its solidity once inspired a passing ad man to use “the rock” as the symbol of a great insurance company (though the concept somehow got refined along the way from Snake Hill to Gibraltar).

On a windy summer evening, this remnant of the Triassic is an excellent spot to sit and look out on one of the weirdest and least reputable landscapes on Earth: the New Jersey Meadowlands. Everybody’s trying to get somewhere else. Rush-hour trains moan and clatter across the wetlands. Trucks on the New Jersey Turnpike roar right through a cut in the rock. A tailwind sends a flight of swallows whipping past and strips back the leaves on the trees so only the pale undersides show.

But what I am feeling, as I sit here on Snake Hill, is deeply, and a little disturbingly, at home. I can see the long traprock ridge of the Palisades, which form the eastern boundary of the Meadowlands. I was born over that way, in Jersey City. Behind me, forming the western boundary, are the green suburban hills where I grew up. The lowlands in between, on either side of the Hackensack River, were a wasteland—“the dumps”—when I was a kid in the 1950s. I remember my family driving back and forth on the broken, cobbled pavement of the Belleville pike, with overloaded garbage trucks fore and aft, past endlessly rising, bulldozer-swarming trash heaps.

Anything could turn up there and often did: a 42-ton whale (decapitated), the ruins of bombed-out London (brought back as ballast on World War II lend-lease ships), dead babies, half-dead dogs from a local pound, and everything North Jersey ever threw into a trash can. Vast garbage-fattened flocks of

*Field of dreams, the new ballpark at Laurel Hill—the Meadowlands’ highest natural point—is part of the first public park created in Hudson County in 75 years. Image-conscious officials gave the hill its genteel name long ago, but locals like baseball player Chris Andretta still call it Snake Hill (or Fraternity Rock, after the graffiti students painted on its sides). Most of the rocks were removed from the hill, once 50 feet taller and five times as wide, by demolition crews in the 1960s.*



seagulls flew overhead, and smoke from underground fires roiled across the road, stinking of burnt rubber and rot. To my parochial school imagination, the Meadowlands then were one of the outer precincts of hell.

They are a much different place today. From Snake Hill I can see where the dumps have been closed and groomed into neat, humped ridges, an area sometimes called the Valley of the Garbage Hills. Just below Snake Hill I can see the big sweeping curve of the Hackensack River, which was nearly dead when I came home after college in the 1970s and is now thriving. One day recently I glanced out from a former dump and saw a black skimmer flying across open water as if balanced on its blade-thin lower beak. It sliced the surface in search of fish, a vision graceful as a figure skater. Peregrine falcons now perch on a riverfront generating plant and pick off starlings at 180 miles an hour.






Rivers of grass still bend with the tides here, and, in places, you get a sense of what the Meadowlands used to be—a metropolitan Everglades. As recently as the 1920s white cedar forests grew in the shallow water, dense and mysterious as any bayou. The buttressed root stumps still jut up from the boggy soil. In places it's possible to imagine, even now, that the Meadowlands might become an Everglades again. Or, just as easily, a parking lot.

From Snake Hill (officially known by the rather prissy name Laurel Hill) I can also see evidence of the startling transformation in human attitudes toward the Meadowlands. Giants Stadium is the symbol of the new Meadowlands. To me it looks about as graceful as an aboveground swimming pool perched on bedsprings. Back in the 1970s the *Star-Ledger*, where I was a reporter, relentlessly touted the Meadowlands as the site for this stadium, to boost New Jersey into the big time. I used to

think of it as “Jersey jingoism,” a vain attempt to shed the state’s image as a non-place, a noisome patch of road between New York and Philadelphia, or as one old insult put it, “a barrel with a bung hole on both ends.”

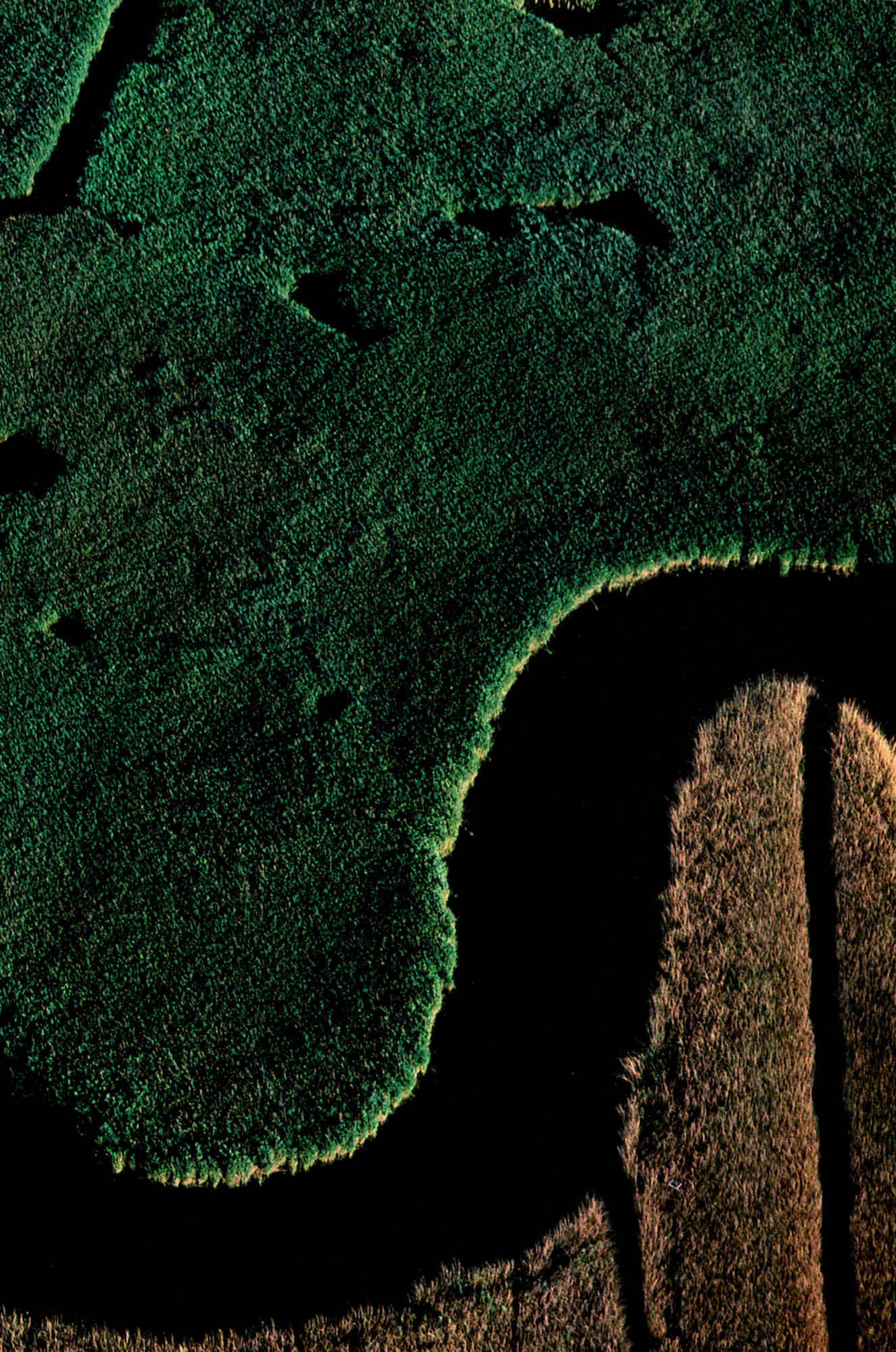
But I was wrong. Not only did the Meadowlands Sports Complex get built, it also stole both of New York’s football teams, the Giants and the Jets, as well as the basketball Nets. The complex was “a perfect antidote,” a grudging New Yorker has written, “to New Jersey’s image as a second-rate place with smelly air and dirty politics.” In one brief period in the mid-1990s the Meadowlands hosted seven soccer World Cup games, the college basketball Final Four, and hockey’s Stanley Cup championship, which the New Jersey Devils won. Bruce Springsteen, the voice of resurgent Jersey attitude, came to sing about “the swamps of Jersey.” “Oh, and we had the Pope,” a sports complex official told me. “That was big.”



An aerial photograph of a marsh landscape. A winding creek, Mill Creek, flows through the center of the image, surrounded by dense, green phragmites. The marsh is divided into irregular sections by man-made ditches, some of which are filled with water. The overall scene is a mix of natural vegetation and human-made infrastructure.

*Mill Creek winds like a snake through a prairie of phragmites, an opportunistic plant that has thrived in marshes disrupted by dam, berm, and road construction. Man-made ditches remain from failed schemes that began nearly a century ago to drain the marshes of water—and mosquito larvae.*







Around the stadium a clutter of new warehouses, hotels, and shopping malls constantly edges farther out into the wetlands. But even the most unjingoistic Jerseyite tends to feel the tiniest bit smug about the transformation of this landscape. The Meadowlands have become the vehicle for brightening the image of an entire state or at least for one-upping New York, and how could anyone see anything disturbing in that?

**I**N MANY WAYS the prime mover of this transformation was the Hackensack Meadowlands Development Commission, a state agency created in 1969. Back then the garbage business dominated the district, said Tom Marturano, the HMDC's director of solid waste. When HMDC employees tried to regulate it for the first time, one operator threatened to run them over with his bulldozer. Another arrived with his wife for negotiations, and she started the meeting by showing the handgun in her purse (shades of *The Sopranos*). "There were 2,000 acres of landfill in 1969," said Marturano, "and if somebody didn't do something, before long there would've been another 2,000." The HMDC finally shut down most of the garbage business in 1997.

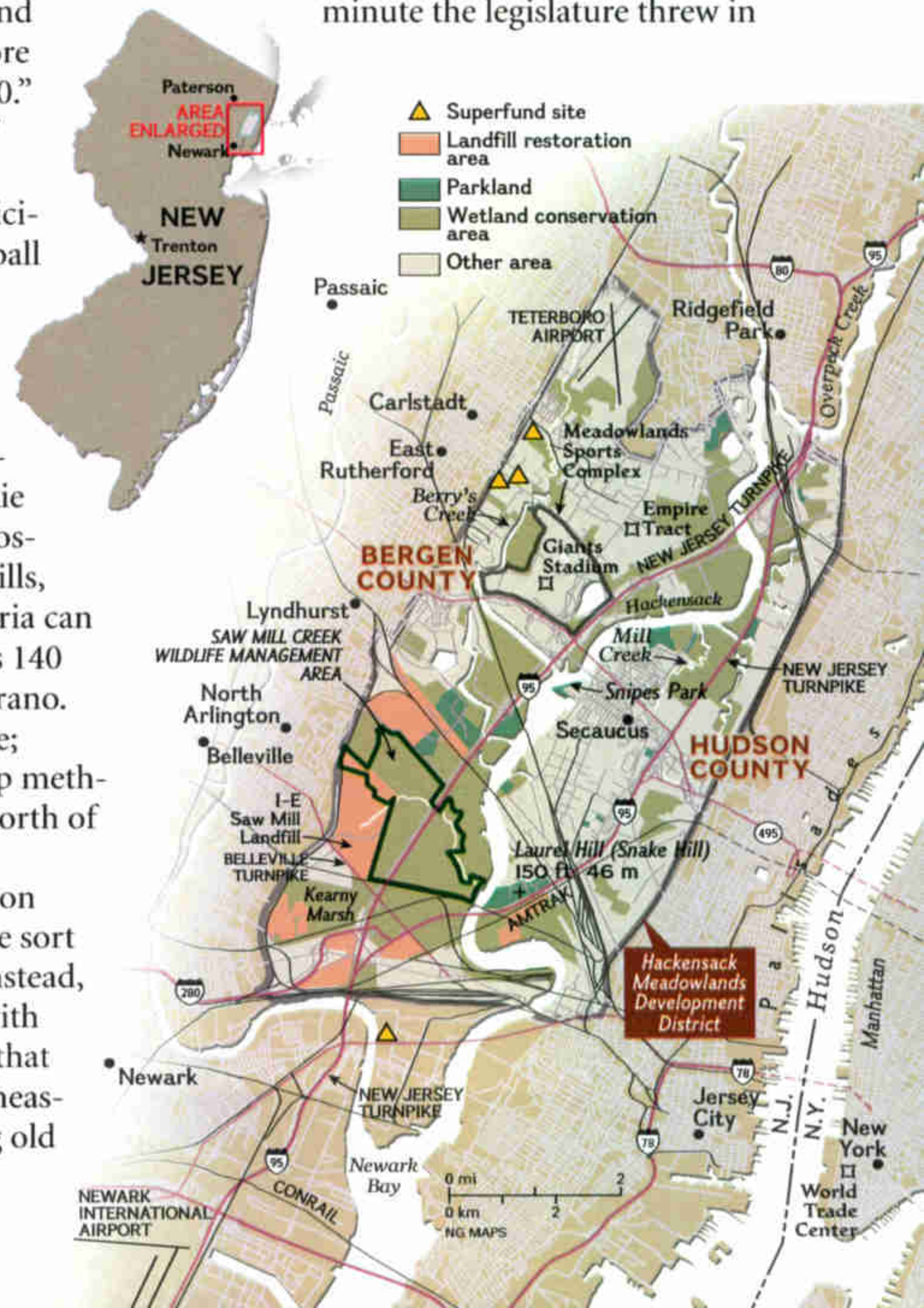
We were out on my childhood municipal dump, a hill called 1-E. "Your baseball cards are probably buried in this landfill, as are mine," said Marturano, whose great love in life, apart from garbage, is fast-pitch softball. Beneath our feet, anaerobic bacteria were steadily eating the landfill, Willie Mays rookie cards and all. Somebody's always proposing some new scheme to develop the hills, for instance as ski slopes, but the bacteria can shrink a hill by 50 feet in a decade. "It's 140 degrees inside the landfill," said Marturano. "The snow melts. These things are alive; they're dynamic." The bacteria belch up methane, and wells now harvest \$550,000 worth of this gas every year.

Someone once proposed grazing bison here, Marturano said, as if this were the sort of weird idea he runs into every day. Instead, I counted a hundred mallards, along with sandpipers and dragonflies, in a pond that has appeared atop 1-E. Ring-necked pheasants have overrun the dumps. Even big old

painted turtles have managed to lumber up the artificial slopes. "They have four-wheel drive," said Don Smith, a former HMDC naturalist, "and they're in low gear."

At the same time it was bringing order to the dumps, HMDC was also sending out staffers like Smith to enforce the federal Clean Water Act, which became law in the 1970s. "You don't just throw the document in the water and the water gets cleaner," said Smith. "Somebody has to go out and find the pipes." If the remark smacks of being underappreciated, it may be because the HMDC seldom gets much credit.

"They wanted to make the place more attractive for development," said Bill Sheehan, an environmentalist who works as riverkeeper on the Hackensack. "They weren't doing it for the northern shoveler or for the river. They were doing it for big-time capitalists." Developers had dreamed of "reclaiming" the Meadowlands into "useful" real estate for centuries, and the state created the HMDC largely as a tool to make this happen. At the last minute the legislature threw in







*Rail yards, power plants, highways, and toxic-waste sites along the Hackensack River seem to confirm an outsider's stereotype of New Jersey. The Hackensack Meadowlands Development Commission (HMDC) was formed in 1969 to regulate development and dumping while preserving parts of the existing wetlands in a 19,730-acre district (map); today only 8,400 acres of wetlands remain.*

a directive to protect the Meadowlands at the same time. The HMDC has always taken this to mean that it should develop a percentage of the Meadowlands and use dumping and development fees to protect what's left. HMDC's grand vision has thus often featured huge new housing and commercial complexes built on wetlands.

One day I took a drive around the town of Carlstadt, next door to Giants Stadium, with Will Roseman, the son of a local truck driver, not yet 40, who has already built and sold his own stock brokerage firm, volunteered as a missionary pilot in Africa, and become an independent financial consultant. He's also the mayor of Carlstadt: "Donna Karan, Ralph Lauren, Coach, they're all in Carlstadt," he said, as we hurtled past warehouses and office buildings. "Did you ever have a Yoo-Hoo? Made in Carlstadt." He drove the way he

talked, making illegal U-turns, passing on the right, mounting curbs, and constantly apologizing, particularly to the local police. His car was a Jeep Wrangler, with his child's Barney doll on the floor and a blistered hood where someone splashed acid the night Roseman, a critic of overdevelopment, was elected.

Carlstadt is a blue-collar town of single-family homes on a slope to the west of the Meadowlands. Its commercial tax base of warehouses, light industry, and chemical plants stands at the foot of the slope, on filled wetlands. Beyond them are more wetlands, not yet preserved or developed, in a great grassy swath out to the Hackensack River. To developers, wetlands like these are a ruined landscape, best converted as quickly as possible into some of the most valuable real estate on Earth. To environmentalists they are urban wilderness and, with a little care, the best hope





**Improbable Comeback** *The Hackensack River used to be a great place to keep a boat—pollution had killed the barnacles. Since the HMDC took over and the federal Clean Water Act was signed in 1972, barnacles and other aquatic animals have rebounded. Fewer than ten fish species lived in the river in the sixties; more than 50 live there today. Crabbers (top left) are finding more in their nets, but authorities still advise against eating the catch. Field biologist Andy Krivenko, in a Giants T-shirt (top right), builds a bridge through phragmites in preparation for counting ducks (above right) and other birds and*





*spraying plants with herbicide, part of HMDC marsh-enhancement projects. New channels, spartina grasses, trees, and trails have been added. Local environmentalists think wetlands here should be left alone and particularly oppose HMDC-approved development projects. Some recovery stories don't have happy endings. Edna Duffy (above left) maintains a butterfly garden in a park on the site of an old metal-plating factory in Secaucus. A few years ago, after the site had been declared clean and safe, carcinogens were found in water flowing under 40 nearby homes, including Duffy's.*





*If it was nasty, they did it here. The Meadowlands were the place people went to do the unpleasant—or illegal—things that no one wants to see, hear, or smell. Before 1969 more than a dozen active dumps covered about one-tenth of the district. The North Arlington Police Department still uses this landfill—the last active dump in the HMDC district—for firearms training.*

for migratory birds, which rest here as they travel the Atlantic flyway, and for coastal fish, which use them as a nursery for the next generation. Caught between the two warring sides is the town of Carlstadt, and Will Roseman.

Roseman grew up in the 1960s crabbing and riding bikes in the Meadowlands and learning the odd language of the habitat. “At 5 or 5:30 every day,” he recalled, “a stench crept across the Meadowlands, and that’s when I knew it was time to go home. I don’t know if a chemical company released material after work, but it happened like clockwork.”

The chemical companies invaded the wetlands from the 1930s to the 1950s, and their heritage endures. Berry’s Creek, where Roseman caught crabs for local restaurants, contains one of the highest mercury concentrations of all the water bodies in the state. The company that put it there is gone now,

as is another company on the creek, which left behind 350,000 gallons of toxic wastes stored on a five-acre stew of illegally dumped chemicals. That company, as it happens, was owned in part by Carlstadt’s former mayor. Both properties are now Superfund cleanup sites, and the owners have written asking Carlstadt to cut their tax assessments, because their land is no longer habitable. “When we get letters like that,” said Roseman, “I question whether we’ve entered the twilight zone.”

As we drove around the Meadowlands, that sense of having entered another dimension—the Jersey Zone—began to seem terribly familiar. I’ve lived out of state for 15 years now, and it occurred to me that maybe what I found so disturbing about the Meadowlands wasn’t just the brazen scent of scheming in the air, but the realization that this was my native element. I almost found myself liking



it—dirty politics being a traditional New Jersey entertainment. Back on Snake Hill, a local historian told me, the human refuse consigned to the poorhouse, the lunatic asylum, the tuberculosis hospital, and the jail were once a precious resource for the Hudson County Democratic machine. When national politicians asked how many votes the county could deliver, local ward heelers supposedly replied, “How many do you need?” Said the historian, “Everybody that was insane, too sick, crippled, or dead, they were still able to vote.” My great-uncle lived and died on Snake Hill, and I like to think that he may have achieved Hudson County’s version of immortality and is voting still.

But entertaining politics can have consequences. Just past Giants Stadium, Roseman showed me the 600-acre site called the Empire Tract. Several years ago developers proposed a retail mall and a mini-city of 14,000 people on the wetlands here. Roseman started out as an ardent opponent of the development, which would have tripled Carlstadt’s population. The mini-city was HMDC’s idea. “They were telling us it was going to happen and we had no choice,” he recalled. “So we sued.”

Then Roseman became mayor, with a rising budget, a dwindling tax base, and, inevitably, an eye for new ratables, meaning tax-paying properties. This is the familiar equation that makes development in the Meadowlands irresistible. To make it even more irresistible, the owners of the tract threatened a countersuit to get their tax assessment cut from the commercial rate, as much as \$350,000 an acre, to the rate for open wetlands, perhaps as little as \$4,000 an acre. Carlstadt began to see the virtue of new construction in the wetlands. The developer agreed to drop the mini-city proposal and to concentrate the development on just 200 acres, rehabilitating wetlands on the remainder of the site, and Roseman agreed not to oppose the mall. “You have to remember, it’s a multimillion-dollar ratable,” he said. “On 200 acres, we could double our tax base.” But a little later, he added, “Theoretically, if development continues the way it has, in a hundred years they’ll be saying, Why was this place called the Meadowlands?”

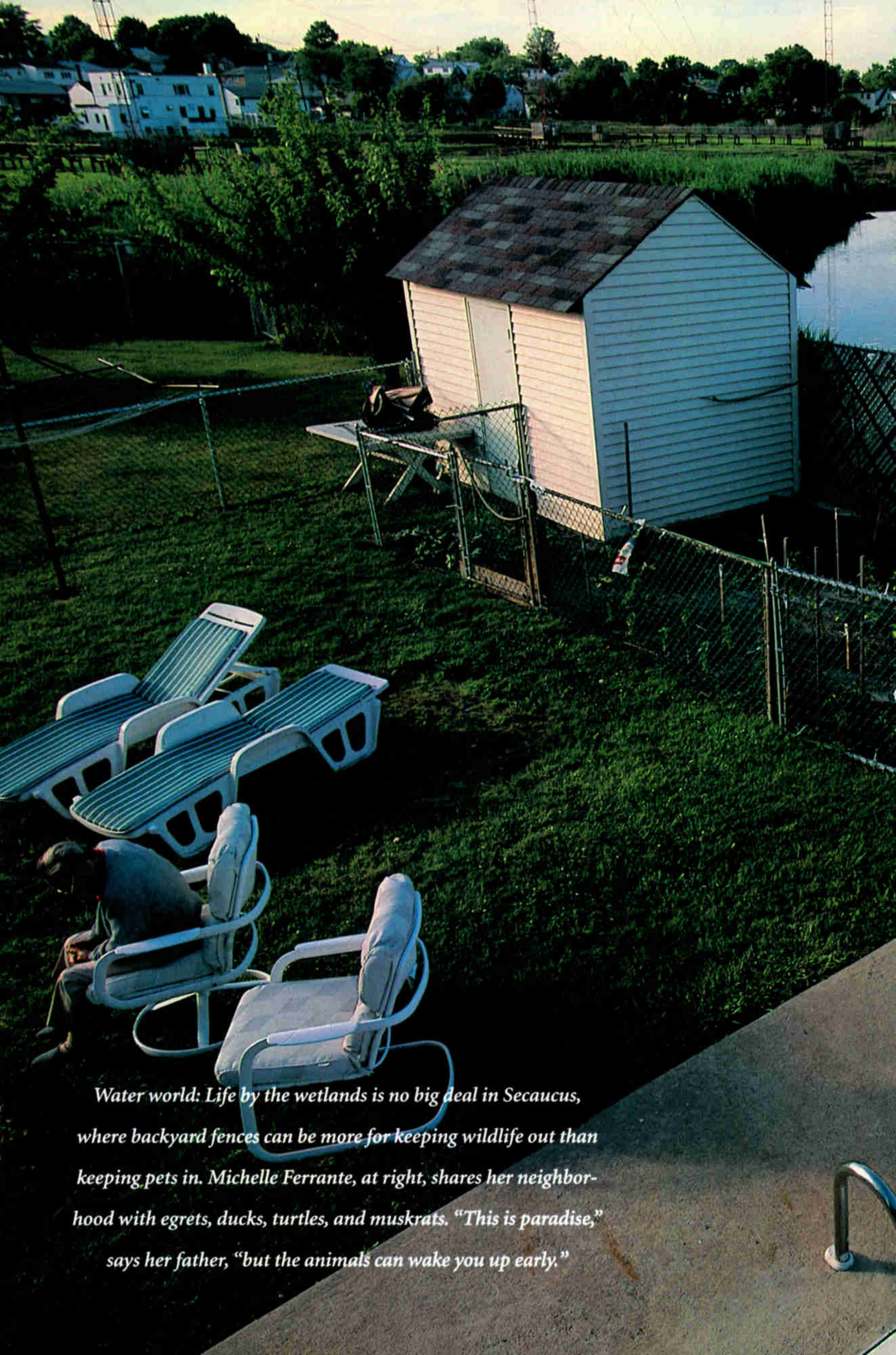
A few days later I went out to walk the land with an environmental scientist for the company that hopes to build its mall there.

The scientist was a systematic advocate of the idea that there are hardly any Meadowlands worth saving even now. He argued that the Empire Tract is mostly dry, because of dikes built early in the century to hold back the river and control the salt marsh mosquitoes. It’s overrun with dense, ten-foot-high stands of phragmites, which are inhospitable to many species. “We’re going to take you out and get you some deerflies and ticks,” the scientist promised with mock enthusiasm, and when I asked what kind of small mammals live on the site, he said, “Norway rats. White mice. The ones that escaped from the lab.”

I got an equally extreme, though opposite, point of view the day I visited the site with Bill Sheehan, who is one of the chief environmental opponents of the mall. The only thing the Empire Tract needs, he said, is for the authorities to remove the dikes and let the water back onto the land. I repeated the HMDC’s argument that losing 200 acres of wetlands to get 400 acres rehabilitated would actually benefit wildlife. A colleague of Sheehan replied, “That’s exactly the opposite of what the scientists say, which is that you can’t make it better by making it smaller.” Sheehan pointed out two northern harriers circling over what would be the mall’s parking lot. “We’re in one of the most densely populated places in the world,” he exulted. “New York’s over there, Paterson’s there, Newark’s there, and we’re watching northern harriers hunt a marsh. That’s why I love this place.”

**O**NE NIGHT I headed to the sports complex, which is what most people in New Jersey mean when they say they love the Meadowlands. If the race-track, the stadium, and the arena all have events, 100,000 people a day can show up, almost all of them by car. Traffic in the area can back up for hours. Tonight was the first game of the hockey playoffs. I was seated in section 230 of the arena, row 6, next to seat 1, which is the home away from home, during hockey season, of Mark Baumann, an electrical contractor. He had missed only eight Devils games here in the past eight years and once drove 30 miles through 12 inches of snow to make the opening face-off. At the moment Baumann was down in front, haranguing the fans in a bellow not *(continued on page 78)*



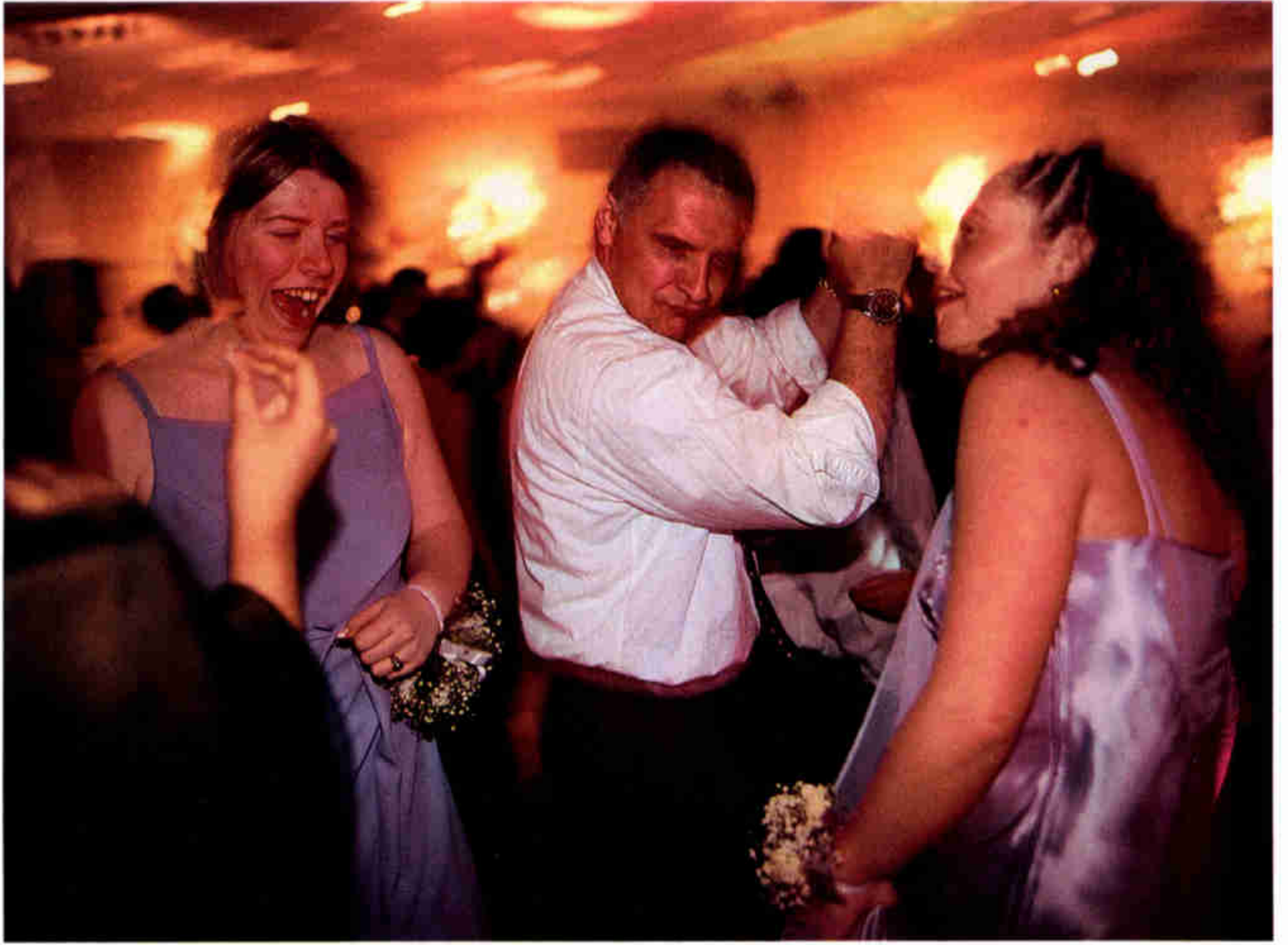


*Water world: Life by the wetlands is no big deal in Secaucus, where backyard fences can be more for keeping wildlife out than keeping pets in. Michelle Ferrante, at right, shares her neighborhood with egrets, ducks, turtles, and muskrats. "This is paradise," says her father, "but the animals can wake you up early."*









**Small Town U.S.A.** *Visitors to Secaucus are pardoned for thinking they've traveled back to a time when folks knew all their neighbors and no one lived on a cul-de-sac. Despite growing pains, life still feels that way here, and to some that's a bigger surprise than finding wildlands so near the big city. Art teacher Doug DePice dances with students at the Secaucus High School prom; friends share a limo into New York City afterward. Karen Olsen's daughter, Christina, is her family's fourth generation to pray at the Church of Our Saviour. Nearby, ballerinas wait to go on stage at Dance Power Studio's annual show, an event*





*attended by hundreds. But Secaucus has changed. Only a few decades ago pig farms thrived on the outskirts of town, giving Secaucus a reputation that won't quit: "When the wind blew the wrong direction, you knew it," admits one older resident. The farms have been replaced by warehouses and malls. Workers from out of town more than triple Secaucus's population during the day. Some young people are so turned off by increased traffic that they plan to leave as soon as they can. Not Meryl Haslach (in limousine, at far right). "It's still quiet and safe," she says, "and if I get bored, Manhattan is 15 minutes away."*





*Just passing through: Many of the people in the Meadowlands at any given moment are on their way somewhere else or staying a few hours for an event. Mainland Regional High School's marching band, practicing in Giants Stadium's parking lot (above), drove up from South Jersey for a competition. More than 135,000 vehicles zip (or creep) across the Meadowlands daily on the New Jersey Turnpike.*

heard since mastodons traveled in the Meadowlands: "D-E-V-I-L-S. WHAT'S THAT SPELL? DEVILS! WHAT'S THAT SPELL? DEVILS!" He bounded back up to his seat, full of raucous energy. "Nineteen thousand and forty fans," he said, pointing to the huge monitors over center ice, which routinely televise his image to the arena, "and I can get 'em all screaming the same thing at the same time."

I asked what made him do it. "Why the Devils? We're in New Jersey," he said, as if this explained everything. Then he turned away (a good thing for me) and roared, "LET'S GO, DEVILS!" I happened to have a copy of that day's *New York Times*, and I showed Baumann the characteristically patronizing headlines about the Meadowlands: "Winning the Dull Way—Must Success for the Devils Mean Tedium for the Fans?"

"That's a New York paper," he said. "Did you read the *Ledger*? They had a 12-page insert. New York never gives us the time of day." He shrugged as if to say, "And who needs it?" At the stadium next door, the Giants fill over 79,000 seats for every game and have a

20-year waiting list for season tickets. Serious fans sign up their children in utero. Next door to the stadium, the racetrack draws a devout crowd to 200 days of horse racing a year, plus simulcasting of races from around the world.

But clearly we were in New Jersey. When I left the arena after the game, hundreds of fans were still milling around outside. They were chanting a slogan not about their rivals in the opening round of the play-offs but about a New York team that was not even a contender. I listened in puzzlement for a moment. Then some lingering strand of Jersey attitude began to resonate in my soul, and I lifted my voice with the others in a strange, three-note, tribal chant—"RAN-GERS SUCK! RAN-GERS SUCK!"—which carried out across the parking lot and disappeared into the darkness of the surrounding Meadowlands.

One thing that struck me, out on a boat a few days later, was that almost none of the fans who regularly make their way to the sports complex ever seemed to get out into the Meadowlands. In the local imagination the area is still a repository for hazardous wastes





NEW JERSEY TURNPIKE



and mob murder victims. (Jimmy Hoffa is persistently rumored to be buried under the end zone in Giants Stadium, a bit like St. Peter under the altar at the Vatican.) But the Hackensack River was placid and lovely. Terns kept me company, cocking their heads down every few seconds to scout for fish and occasionally plunging into the water to catch one. I found I could travel for hours and never see another boat, and I began to wonder where all the fishermen and birders had gone.

One day I put the question to Don Smith, the former HMDC naturalist, who grew up hunting and trapping muskrat in the meadows. We were out at the Kearny Marsh, which is a case study in how weird the Meadowlands habitat can be. Back in the 1960s, Smith said, the Jersey Turnpike got built at the far end of the marsh. Then a culvert underneath it became clogged and cut off the tidal flow of salt water. The Kearny Marsh promptly blossomed into one of the richest freshwater wetlands in the state. Black-crowned night herons still have a rookery there and perch on the shore looking professorial. Moorhens skitter along the mudflats with their bumpy ostrich trot.

Smith sometimes leads tour groups out here to look for least bitterns and other rare birds. I asked him why the HMDC hadn't done more to get people out into places like this. "We want people to use it . . . but on a controlled basis," he said. "You wouldn't want to come out here and see wall-to-wall canoes." At that moment, there wasn't a canoe in sight.

The HMDC likes to boast that it has built numerous parks in the Meadowlands. But Snipes Park in Secaucus seemed to me to epitomize the agency's approach: It was unmarked and accessible by way of a mall parking lot. I thought about a proverb that an HMDC educator used to quote: "In the end we will conserve only what we love. We love only what we understand. We will understand only what we are taught." It seemed as if the revitalized Meadowlands were being hoarded up as the HMDC's secret.

**M**Y LAST DAY in the Meadowlands I went canoeing with the new HMDC naturalist, John Quinn, who has written a book about the Meadowlands called *Fields of Sun and Grass*. Quinn, a placid, pipe-smoking 60-year-old, spent much

*Close enough to the turnpike to hear the traffic's rumble, duck hunter Mike Lawn sits in his boat and waits for birds at Saw Mill Creek Wildlife Management Area, one of few places in the Meadowlands where spartina has returned in force. Behind him the World Trade Center reflects the evening sun. Lawn has hunted here for a decade. "This is a pristine marsh, and it's in the shadow of skyscrapers and one of the world's busiest corridors," he says. "It's a surprise."*



of his childhood bushwhacking out into a northern spur of the Meadowlands called Overpeck Creek. Back then the marsh at the end of Brinkerhoff Street was still a magical place for a kid to invent wilderness treks. Quinn discovered marsh hawks and mummichogs there. Then, in the 1960s, a county landfill and the New Jersey Turnpike both came to Overpeck. "They raced down this valley like a flying panzer division," he said. "It was devastating. You'd see them landfilling through the nests of herons and egrets and gallinules." In a few years the valley was buried under 15 feet of garbage.

We pushed out into the creek toward the opposite shore, where the glass towers of an office park now stand. The banks of the creek were covered in ailanthus trees and showy pink mallow flowers. "It looks almost tropical," Quinn said, with the barest hint of irony. "Ailanthus means tree of heaven. So that's





where we must be.” A kingfisher preceded us up the shore and a green-winged teal swam out across our bow. But close-up, the banks of the creek revealed themselves as a kind of geologic layer cake of garbage, undulating striations of foam rubber, plastic bottles, old toys, and rusting appliances, which spilled down steadily into the water. Carp rolled their scaly serpent-like flanks in the shallows.

As Quinn paddled, he was whistling strands of “Stars Fell on Alabama.” He had arrived at a certain bittersweet acceptance of the transformation that had taken place here. But I was a visitor, rediscovering home ground. It suddenly seemed to me that New Jersey had not, after all, triumphed over the myth of itself as a non-place. It had surrendered to it utterly, methodically burying one of its most characteristic features, the Meadowlands, as if they were an embarrassment. Everything was being filled and flattened and made more efficient.

Even Snake Hill had been largely demolished by quarry machinery and converted into gravel for roadbeds. The Meadowlands had once been a real place—difficult, but distinctively themselves. Now, with the help of the HMDC, they are becoming that most coveted object of modern civilization, a destination, an assemblage of sports teams and malls that could be almost anywhere.

“Well, your car is still there,” Quinn said, when we got back to the parking lot, “and in New Jersey that’s always a hopeful sign.” We drove out past the office park, onto an overpass above the turnpike. Quinn looked out the window at a dozen lanes of traffic hell-bent on getting elsewhere, and quietly remarked, “This is what remains of my childhood valley.” □

**MORE ON OUR WEBSITE**

Share your own wetlands experiences and see more photographs by Melissa Farlow at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).



## Antarctica

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### Science on Ice

Dressed for the office, Brent Sinclair focuses on signs of life in soil from Cape Bird. "I'm fascinated by extreme environments," says Sinclair, of New Zealand's University of Otago, who studies how temperature changes affect tiny invertebrates adapted to living on the edge. "This place is as extreme as you can get. Physiological studies here can tell us a lot about what limits life."







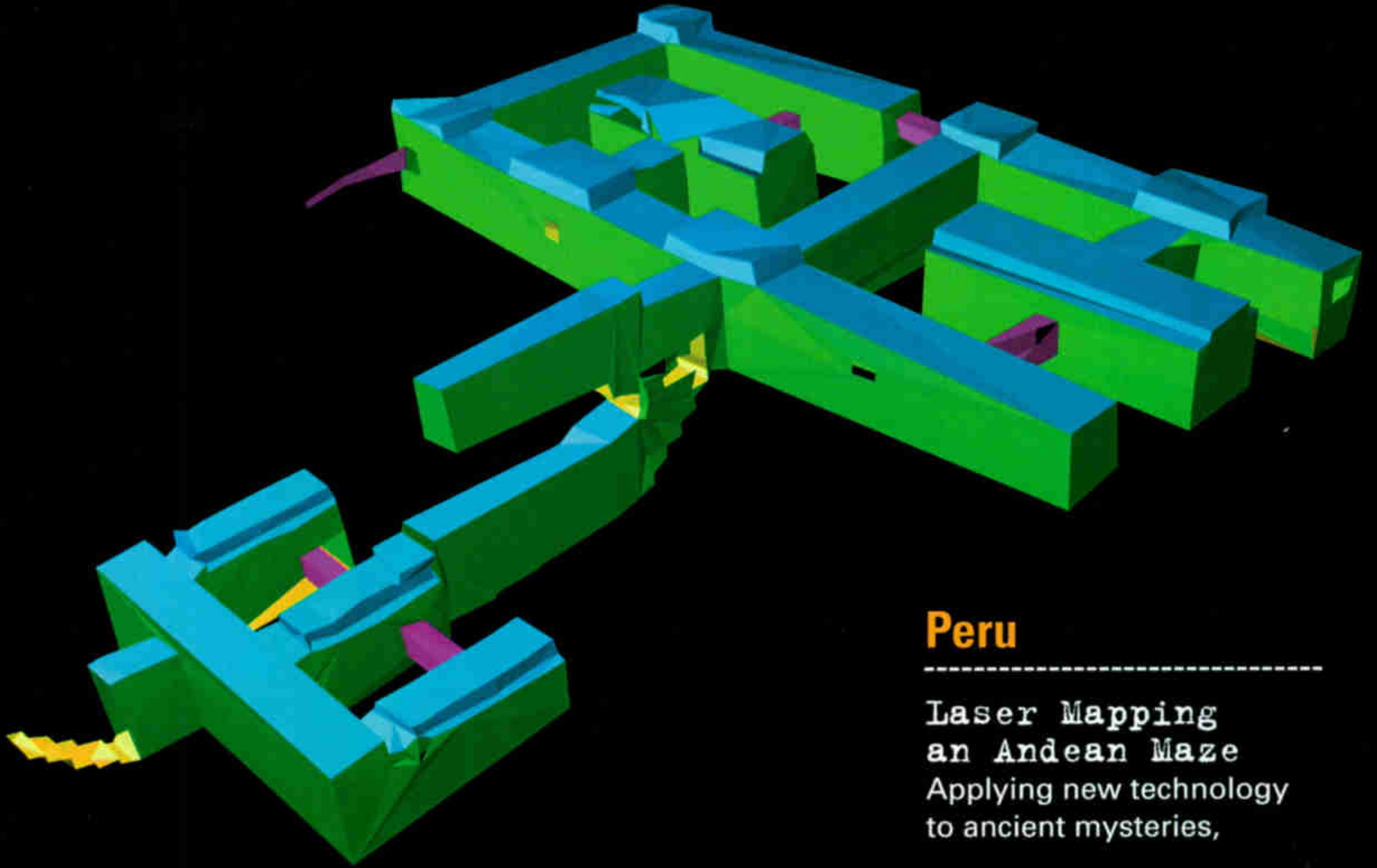
# Update from the field

FROM THE LIFE OF AN INSECT to the death of a civilization, scientists and explorers continue to study the world through National Geographic-funded projects and expeditions. Follow the committee's work online at [nationalgeographic.com/research](http://nationalgeographic.com/research).





“With 3-D maps, it’s like looking through the



## Peru

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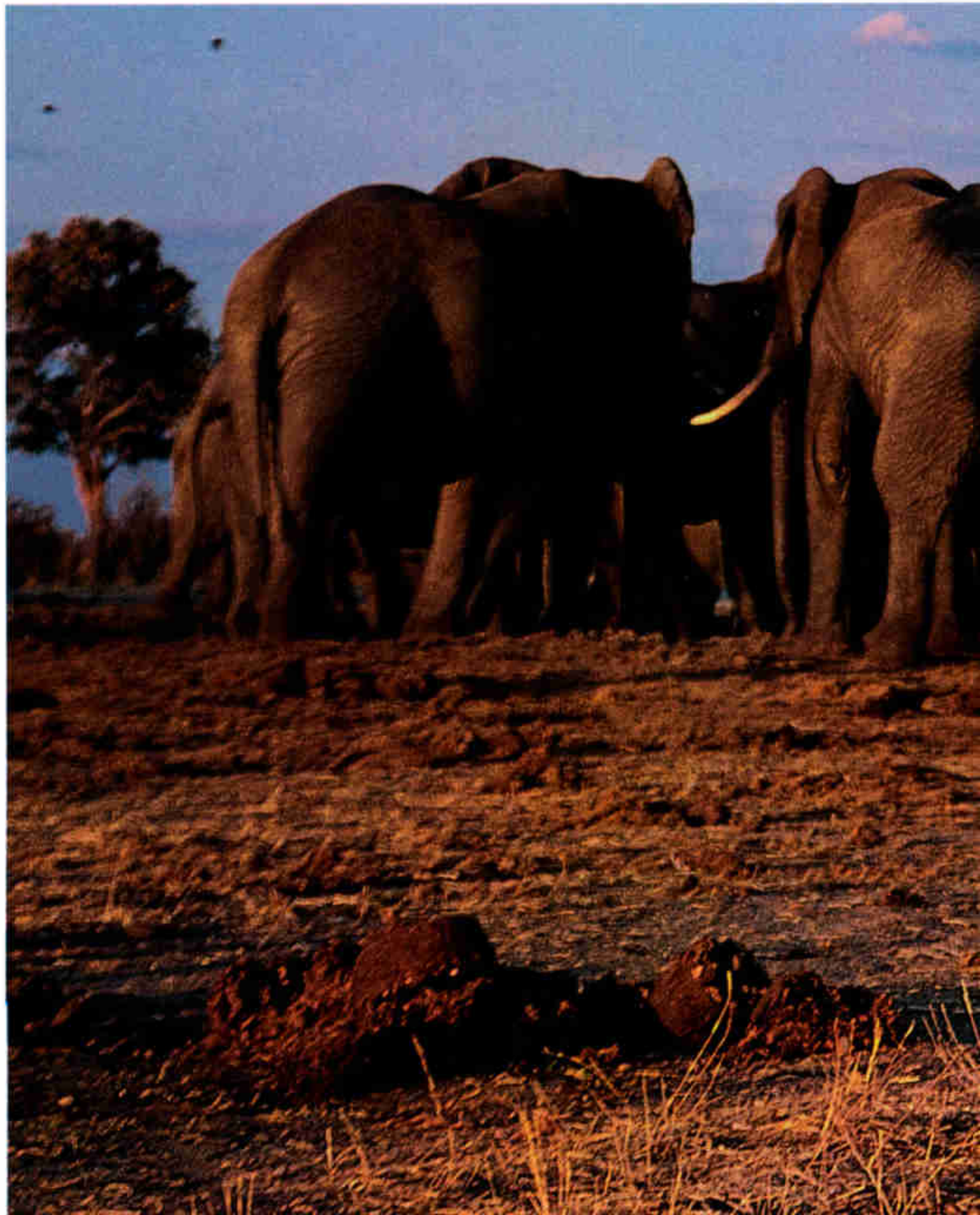
Laser Mapping  
an Andean Maze  
Applying new technology  
to ancient mysteries,

## Botswana

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### Getting the Dirt on Elephants

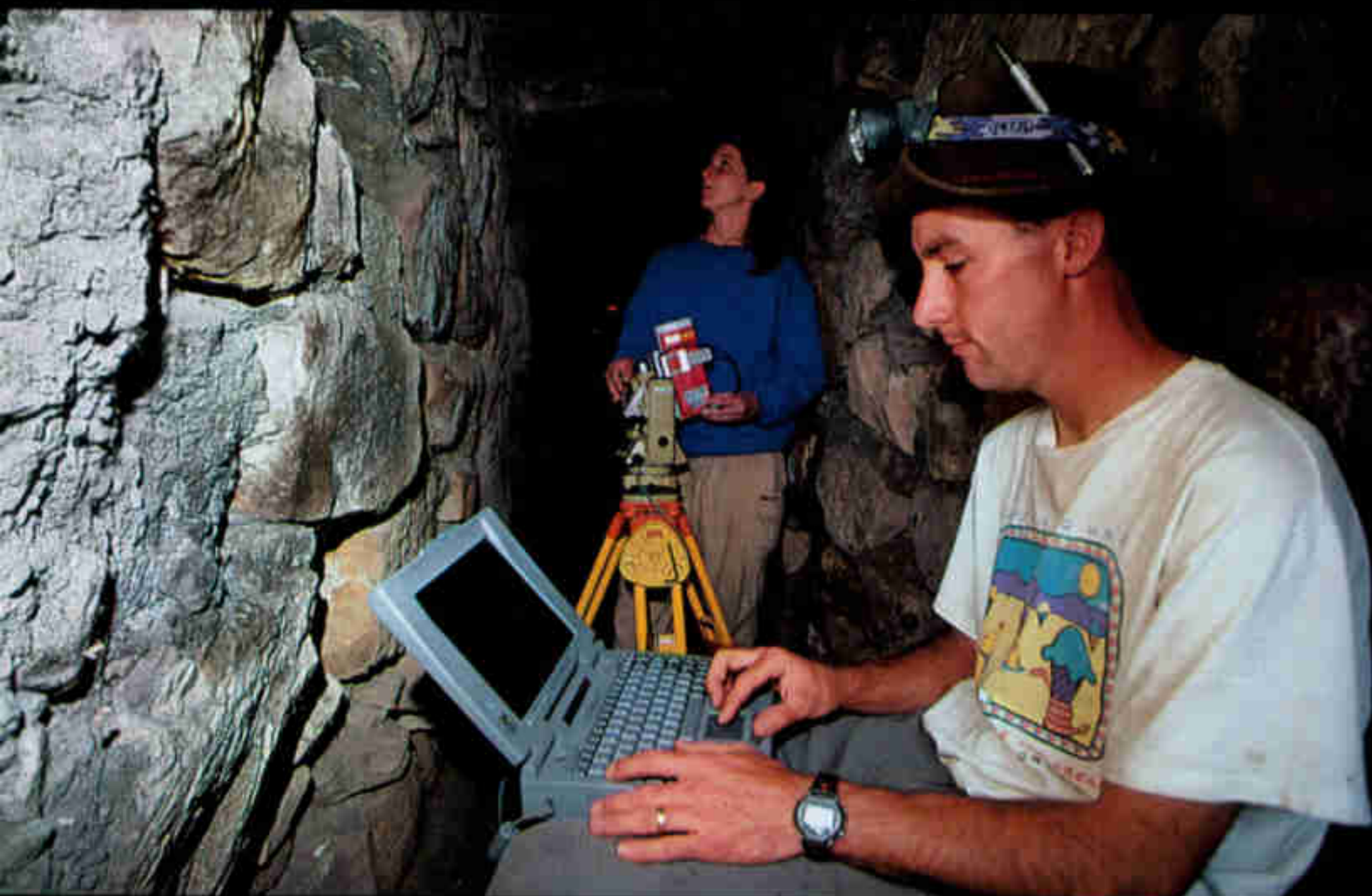
With a backdrop of bulls, Raphael Ben-Shahar studies a vial of African earth collected in the Savuti region—where elephant density is high. “The relationship between plant composition, soil properties, and elephant density can help us determine the carrying capacity of an area,” says Ben-Shahar. “We can make better management decisions if we know how many animals a habitat can sustain.” Though he digs the soil, Ben-Shahar, a zoologist at Oxford, is most inspired by the animals themselves. “Watching elephants interact at a watering hole is for me the essence of Africa,” he says. “Sitting in their dung only adds to the experience.”





temple with X-ray vision.”

—Silvia Rodriguez Kembel



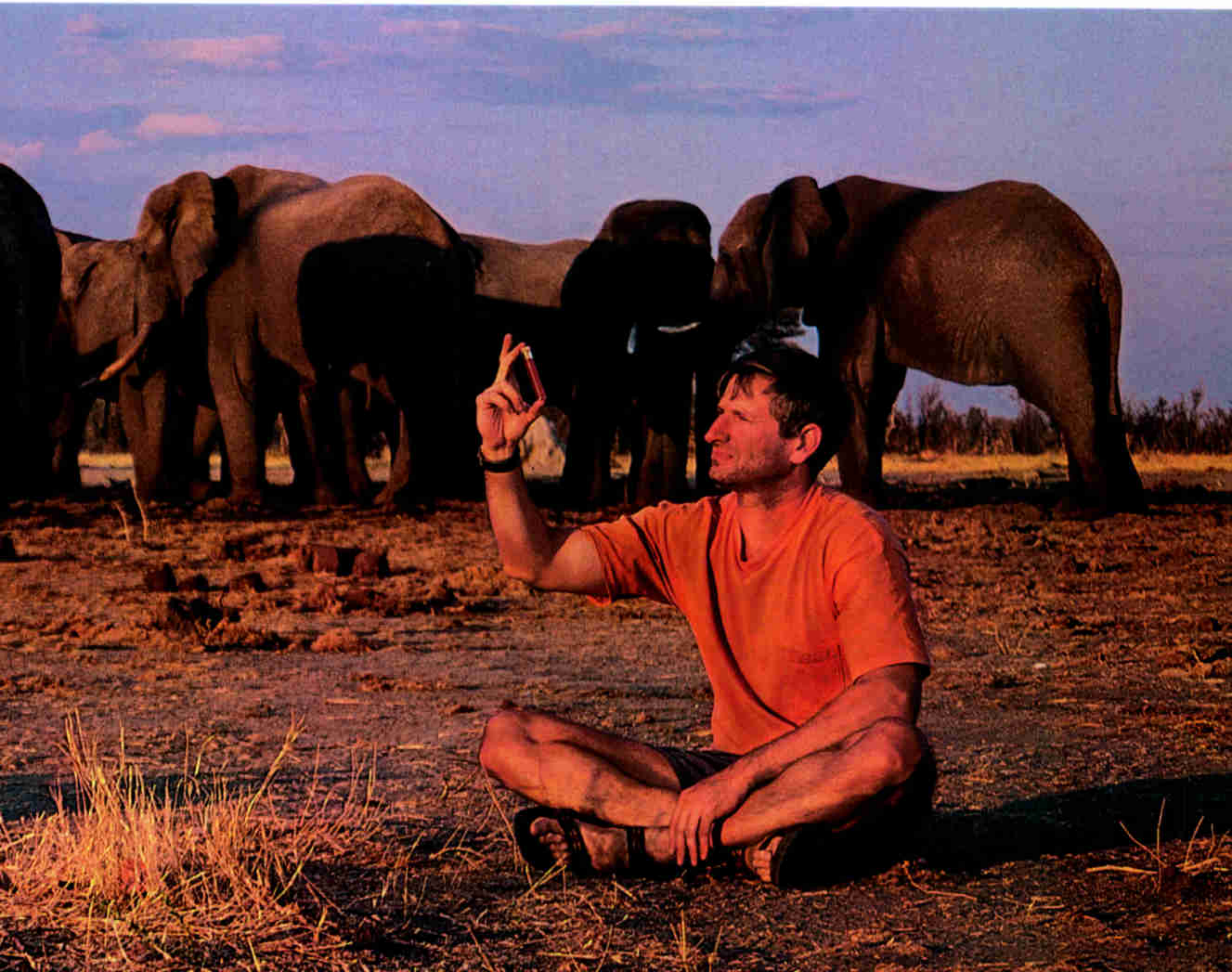
CARLOS DAVID RODRIGUEZ (ABOVE), JOHN KEMBEL AND SILVIA RODRIGUEZ KEMBEL

shoot at what was once out of reach.” The laser calculates angles and distances, and the computer generates a 3-D image. A digital rendition of the Gallery of the Labyrinths (far left)—one of 26 passageways at the site—is based on thousands of laser data points.

“By mapping the galleries and comparing their architecture, we hope to determine their construction sequence, which may tell us something about how this society developed,” Silvia says. “We believe the complex was supposed to convince people of Chavín’s power. It sure has worked on us.”

Stanford University’s Silvia Rodriguez Kembel and husband John Kembel (above, foreground) shed light on early Andean architecture at Chavín de Huántar, a

famed temple from the first millennium B.C. “Previous maps of this site captured little spatial information,” says Silvia. “Our laser technology lets us point and





“Sometimes when a king is forced out, the city

## Ecuador

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### Out on a Limb

“Keith is a real monkey, always climbing around in the trees,” says the Smithsonian Institution’s Jason Hall about University of Florida colleague Keith Willmott—seen navigating a fallen limb to net metalmark butterflies. Friends since high school and butterfly fanatics for at least as long, they have discovered over 50 new species while surveying the butterfly fauna of Ecuador. “We want to know what’s out there—to study the insects’ taxonomy and evolution,” Hall says. “Ultimately we want to conserve Ecuador’s biodiversity.”





dies. That's what happened here." —Stephen Houston



MARK A. PHILBRICK, BRIGHAM YOUNG UNIVERSITY (ABOVE); JASON HALL (LEFT); STEPHEN HOUSTON

## Guatemala

**Rocks Tell Tales**  
Carved in stone, the life of an eighth-century A.D. Maya king is celebrated on a mortuary panel (right) from the pyramid that entombed him. The pyramid is part of a complex known as the Acropolis of Piedras Negras. According to Stephen Houston of Brigham Young University, who studies the royal ruins, "As enemies ransacked the palace, the panel was likely dislodged from the temple summit and sent tobogganing to the ground." Houston kneels before Altar 4 (above) —a giant jaguar paw from the site probably used as a platform for sacred offerings.

UPDATE FROM THE FIELD

"The royal palace was the center of the city," he says, "a gigantic stage for productions that mattered to the kingdom." What matters now to Houston are the bits of Maya history scattered in the

forest. "It's absolutely gripping to be out there among the quiet stones," Houston says, "where the sounds of royal life and ritual have been replaced by the cries of monkeys."



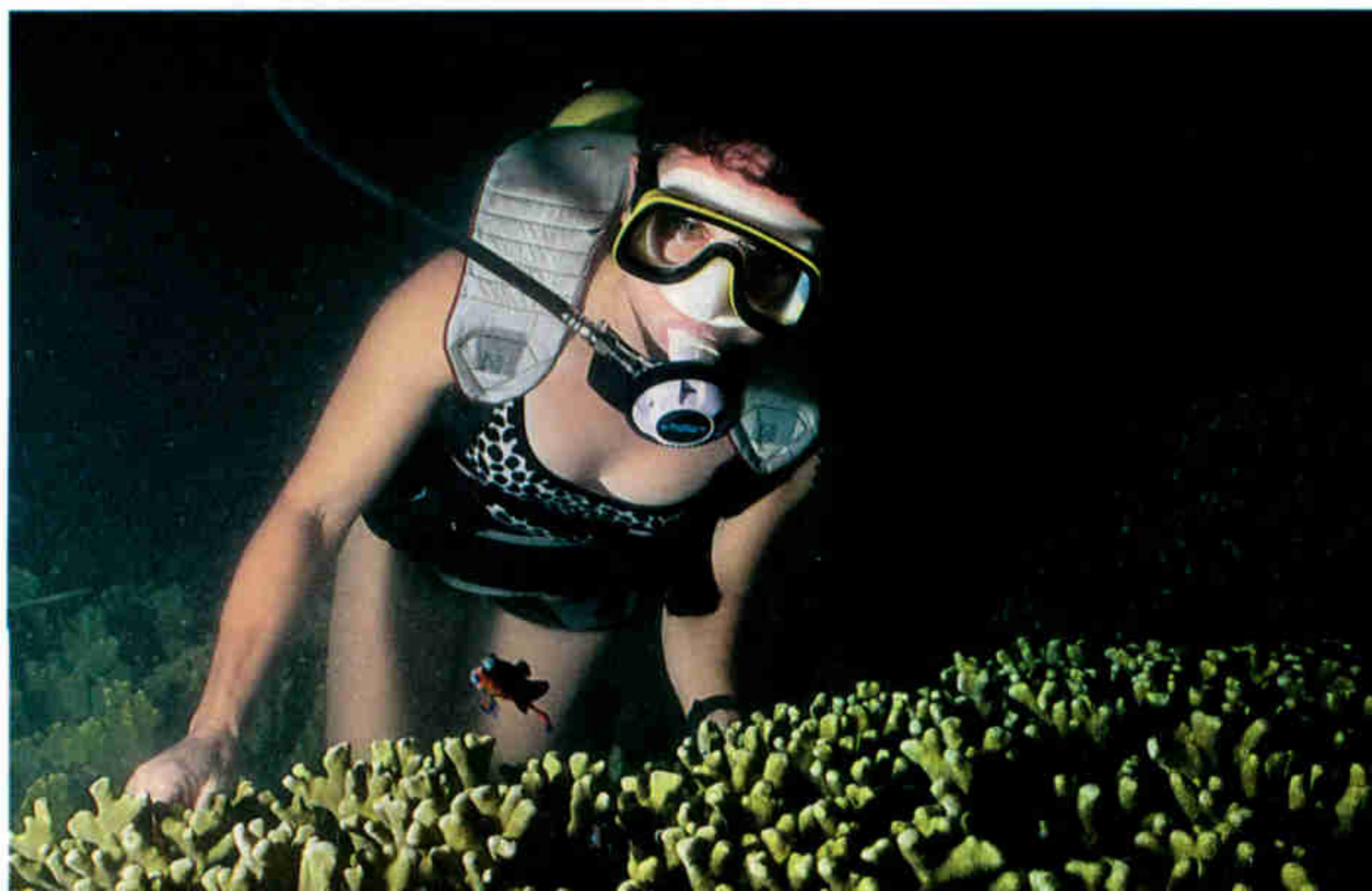


“I heard ba-ba-boinggg! I thought, could a whale



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really be making that sound?"

—Jason Gedamke



## Australia

**Deep Down Under**  
Eyed by a dwarf minke whale, Jason Gedamke dangles in a dreamy world of unearthly acoustics. "When a nearby minke calls, you feel it in your chest," says Gedamke, who, under grantee Daniel Costa of the University of California, Santa Cruz, records the whales' unique calls to learn which individuals are sounding off and when. "These minke whales are incredibly curious," he says. "We stop the boat, and they come to us. It's a great opportunity to listen in on their world."

QAMAR SCHUYLER (ABOVE); GEORGE MITCHESON

## Micronesia

### Prize Specimen

In full regalia, a courting male mandarinfish (right) flares his fins to woo the smaller, egg-filled female. "We want to understand the reproductive biology of this species so we can gauge how the aquarium trade affects it," says the University of Hong Kong's

Yvonne Sadovy, who watches a pair rise above the coral to spawn (left). "The trade helps foster appreciation for species and reefs," she says. "It can



be good for conservation." Collectors favor the showy males, and Sadovy wants to know if selective harvesting is hard on populations. Meanwhile her team has had luck raising mandarins in captivity. "Eventually," she says, "we hope aquarists will seek out cultured fish." □





## *Last Stand for Southern Africa's First People*

*Born into poverty, a Bushman herder on a Namibian farm has little to show for his labors beyond the clothes he wears. Reduced to servitude in the land that was once their ancestors' domain, southern Africa's 85,000 indigenous Bushmen fight to win back a foothold along with their pride.*





Bushmen









*A Bushman smears his legs with antelope blood in a rite witnessed by visitors to Namibia's Intu Afrika, a commercial game reserve. As land where Bushmen can hunt dwindles, many court tourism to survive. "Mythology is one of their few assets," says anthropologist James Suzman.*



By Peter Godwin

Photographs by Chris Johns

NATIONAL GEOGRAPHIC PHOTOGRAPHER

**P**ITY SOUTHERN AFRICA'S FIRST PEOPLE. Pity the people with no name. For when you are the only ones, you have no need to distinguish your kind from others. Pity those whose exclusive domain once stretched from the Zambezi to the Cape of Good Hope, from the Atlantic to the Indian Oceans. Their Tswana neighbors in the Kalahari, who arrived here 1,200 years ago, call them the Basarwa, the "people who have nothing." Their pastoralist cousins, the Khoi, call them San, outsiders or vagabonds. They are a people with an ancient past but almost no recorded history, save for one glorious exception, rock paintings of antelope and elephants, dancers and hunters, some of which remain startlingly vivid despite being lashed by wind and rain and baked by sun for 3,000 years. The most recent paintings show sailing ships and mounted horsemen. Then there were no more.

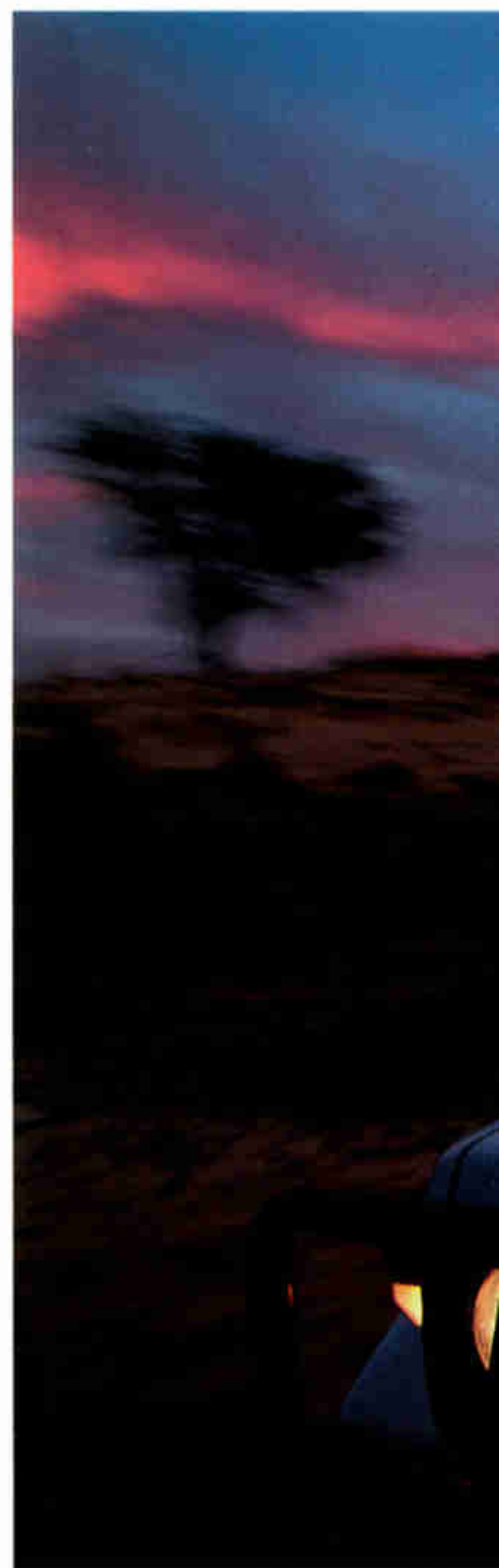
European colonists who waded upon the shores of southern Africa 350 years ago called them simply Bushmen. Deeming them "untamable" and a threat to livestock, settlers treated the Bushmen as vermin, killing them in great numbers. In a 19th-century anthropological survey titled *Researches Into the Physical History of Mankind*, J. C. Prichard summed up the Bushmen's lot: "Human nature is nowhere seen in a more destitute and miserable condition."

Advertised as "the dwarf earthmen of Africa," small bands of Bushmen were paraded around Britain in popular Victorian freak shows. Early anthropologists saw them as "living fossils," the missing link in man's evolution, not entirely human. And the extraordinary Bushman languages, with their tonal clicks, were regarded by another anthropologist as animal sounds rather than human speech, "like the clucking of hens, or gabbling of turkeys."

The Bushmen soon languished on the outer edges of society, in the basement of southern Africa's brutal caste system. Many became virtual slaves of the cattle-owning Bantu people, and others worked for occasional handouts on white farms.

There are about 85,000 Bushmen alive today, teetering on the cusp of cultural extinction, mostly in the remoter reaches of the Kalahari Desert, in Botswana, Namibia, Angola, South Africa, Zimbabwe, and Zambia. They are among the most intensively studied aboriginal people on Earth. This interest is stoked by the idea that the Bushman is one of our last connections with a hunter-gatherer existence, a way of life that was a human universal until some 10,000 years ago, in a time before man domesticated animals or grew crops. A time when man depended directly on nature for survival.

Bushmen have not been living in splendid isolation as hunter-gatherers for some time now. Some anthropologists believe that the final transformation of the Kalahari Bushmen accompanied the widespread introduction in the 1950s of water wells known locally as boreholes. One of the Bushmen's main advantages over other societies had been





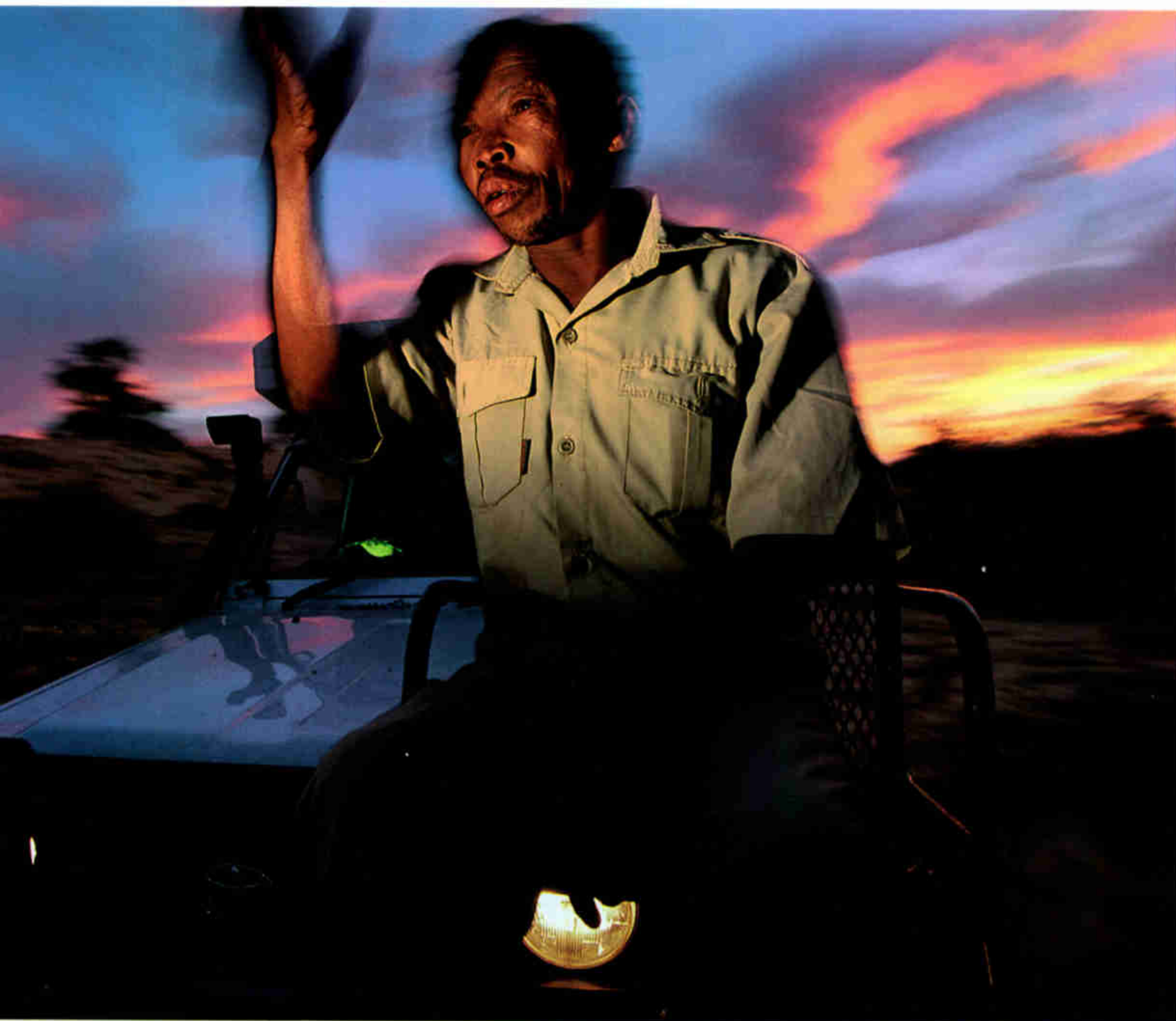
### **Mounted tracker**

*Buks Kruiper leads a scientist to lions in the area from which his Bushman group was evicted in 1973. Until South Africa allowed them back in 1999, Kruiper drove a road grader, danced for tourists, and took to drinking. He missed the land, he says—it is in his heart.*

their ability to survive without surface water. Their arcane knowledge of where to find liquid-bearing melons and tubers and their system of burying sealed ostrich eggs filled with water during the wet season and recovering them during the dry allowed Bushmen to live where others could not. Now that talent has lost its point. Boreholes opened up the land to pastoralists, and Bushmen were dispossessed.

Of the 25 or so surviving groups, the closest thing left to so-called genuine Bushman society—the conservation icons living in perfect harmony with nature and romanticized in the movie *The Gods Must Be Crazy*—can be found in the Nyae Nyae district of northeastern Namibia. The Bushmen there call themselves the Ju/'hoansi, which means “real people,” and they number about 1,600. (The slash after “Ju” is one of four marks—/, //, !, and ≠—commonly used as notation for different click sounds in Bushman languages.)

Nyae Nyae is a flat, dry territory on the border with Botswana. It used to be an apartheid-style “homeland” when Namibia was in effect a South African province. Eight years after Namibia’s independence in 1990, Nyae Nyae was declared a conservancy to be run by an elected committee of Bushmen. The Ju/'hoansi are fortunate to live upon their own ancestral land, or at least part of it.





Den/ui village is one of several dozen that make up Nyae Nyae. It lies at the bottom of a rough dirt road in scrubby Kalahari bushveld. The grass shelters in which the Bushmen live are little changed from those their forefathers inhabited, designed to give only rudimentary shelter for what was, after all, a nomadic lifestyle, with the family groups constantly moving to different hunting and gathering grounds. But today the village is a permanent one, served by a molded fiberglass elementary school and an artesian borehole that gurgles with fresh water.

**W**E SET UP CAMP IN A CLEARING in the bush close to the village, and that night I lie awake listening to the hawking of phlegm-filled chests, the hacking of tubercular coughs, and the wavering wails of the babies, which compete with the yelps of patrolling jackals to fill the dome of stars above us. It is winter in the Kalahari and bone-achingly cold when the cocks begin to crow a few minutes before four. As I emerge from my tent, “dawn’s heart,” as Bushmen traditionally call Jupiter, is burning brightly on the horizon. The water in my billycan is frozen solid.

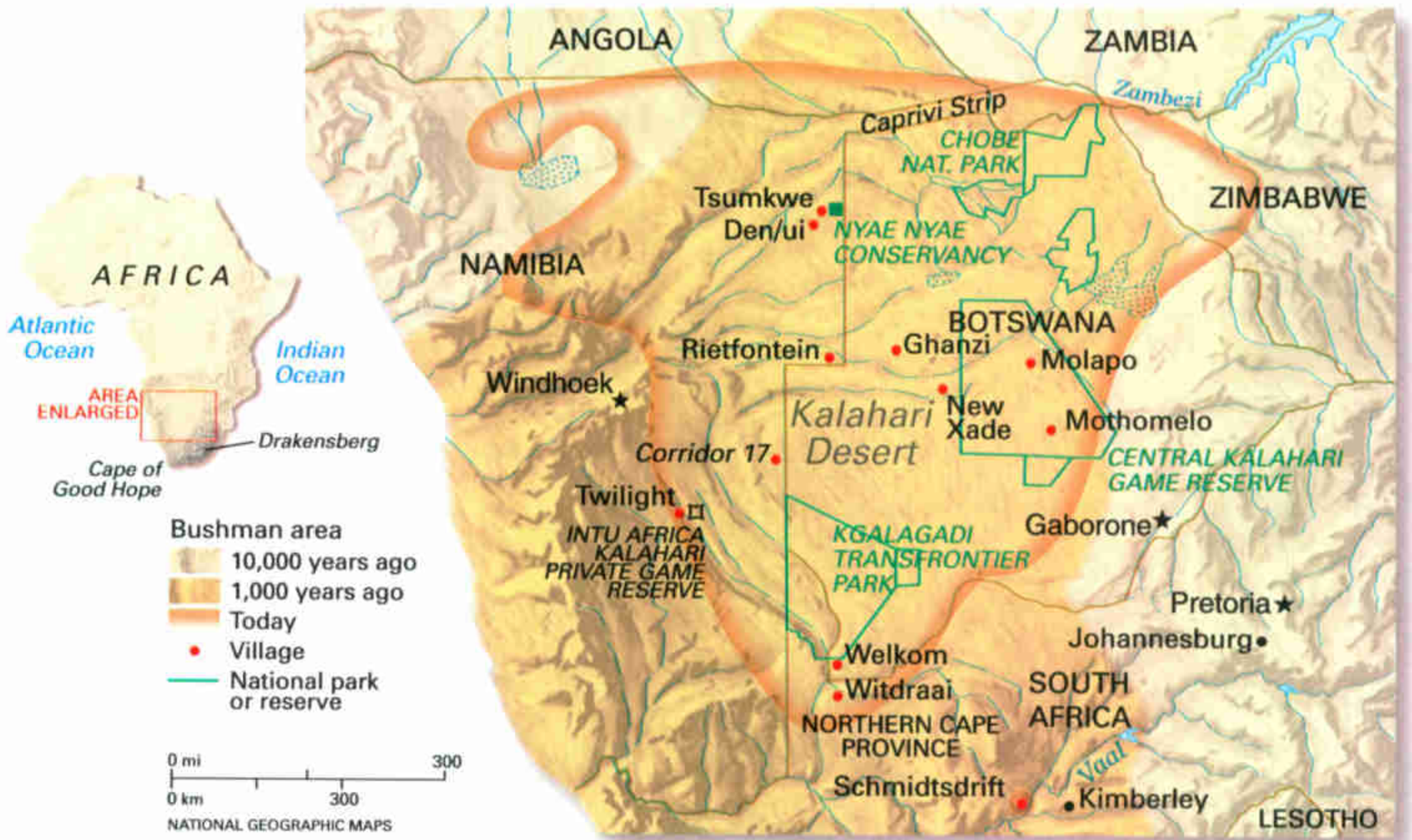
When we enter the village, the families are huddled around their tiny fires; some of the children are shirtless, and the adults have, at most,

### **A squatters’ camp**

*in South Africa is a barren playground for children. Over centuries, migrations south by Bantu herders and farmers encroached on southern Africa’s hunter-gatherers. Then European colonists pushed most Bushmen into a few Kalahari Desert enclaves.*







a single threadbare blanket clasped around each pair of bony shoulders and each toast rack of prominent ribs. They are breakfasting meagerly on berries and weak tea.

N!amce, a Den/ui leader, sits on a log making arrows. He rolls the yellow reed shaft in the ashes, then squints down its barrel and straightens it. He smears bitumen from an old car battery onto the end of the shaft, heats it again, and binds twine made of kudu sinew around it. He cuts a notch at the back end for the bow string to slot into, and on the other end he inserts a spike of giraffe bone, which connects to another little cylinder of reed into which the arrowhead, a length of gauge wire whose end has been hammered into a triangle, is forced. He gingerly coats the four inches of the wire shaft behind the arrow tip with poison stored in a steenbok horn.

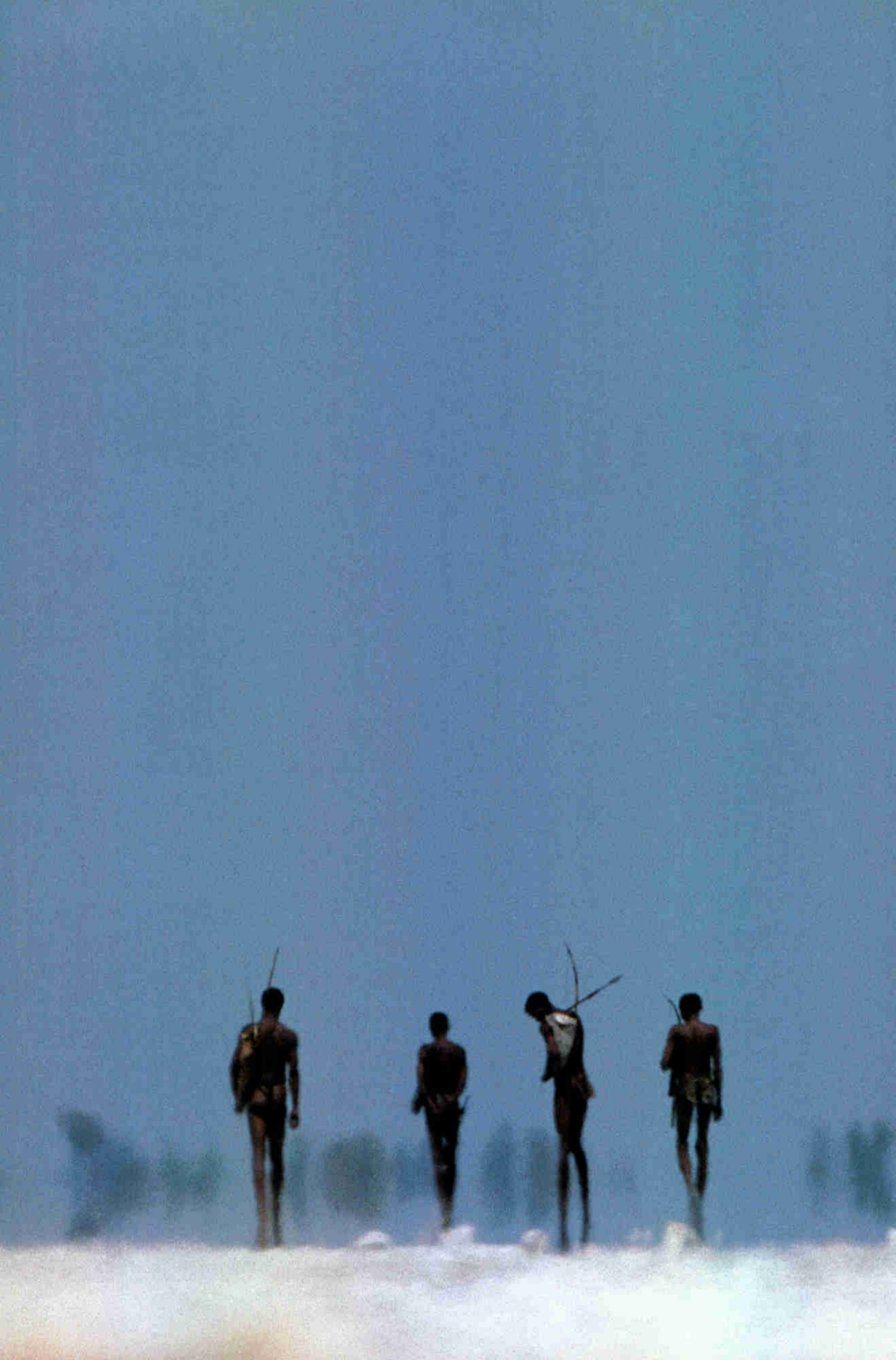
Bushman poison is legendary. Some hunters are said to use a mix of snake venom and cactus juice; some prefer the essence of crushed scorpion and trapdoor spiders. Here in the northern Kalahari they use the most lethal of all Bushman poisons, the grubs of the *Diamphidia* and *Polyclada* beetles, mixed with tree gum. The poison kills by entering the bloodstream and causing paralysis. A small antelope, cleanly hit, will take perhaps 24 hours to die. A bigger one, several days. And there is no certain antidote.

It was the Bushmen's possession of poisoned arrows that terrified early settlers so. John Campbell, a missionary, described what happened to a companion hit in the shoulder by a Bushman arrow in the early 1800s: "His appearance alarmed us, being greatly swelled, particularly about the head and throat. He said that he felt the poison gradually work downwards to his very toes, and then ascend in the same manner. His countenance was frightful, being so disfigured by the swelling." The man died the next evening.

After the intense concentration of handling the poison, N!amce takes a smoke break. He stuffs the end of his metal pipe with a filter of fibrous bark, scoops up a handful of

(Continued on page 102)







*Figures in a mirage, Bushmen wearing skins and carrying bows and arrows cross a salt pan in Namibia's Nyae Nyae Conservancy. Use of guns, dogs, and horses is restricted, so they hunt the traditional way. They live in a village built to lure tourists, and most days they wear Western clothes.*











*Women farmworkers near Ghanzi, Botswana, still go into the bush to gossip and snack on wild plants. Gathering once provided 70 percent of the Bushman diet, but ancient scrubland has been converted to cattle ranches. Now government relief provides the bulk of the people's food.*



hyrax droppings and loads them into the pipe. He sucks up the acrid smoke, exhales contentedly, and passes the pipe to N $\neq$ aisa, an elderly woman whose forehead is fringed with beads from which a metal triangle hangs down, swinging below her nose. She also sports a paper-clip earring. When the pipe reaches me, I pass it on.

Armed with quivers of poisoned arrows, a party of men sets off on a hunt. The men walk fast, glancing down from time to time but barely breaking stride to observe the ground for tracks. My Bushman translator, who tells me to call him /Ai!ae/Aice, explains how they read the ground—"the same way you people read a book; the bush is our book." They can determine the age and sex of animals by reading the signs they leave behind. One young hunter drops to his heels and examines the droppings of a hartebeest; the more roughage, the less efficient its digestion and the older the animal. A male springbok, explains /Ai!ae/Aice, will often bring up the rear of the herd, and a male gemsbok will butt tree trunks with its horns to scent its territory.

Bushmen can measure the age of tracks by the time it takes termites to rebuild a nest that's been trampled on, or a blade of grass to spring back to its usual position, or a spider to repair its cobweb. When Bushmen hit an animal with an arrow, they don't immediately sprint after it; they go to where it was standing and memorize its particular spoor. Only then will they begin to patiently track it until it falls.

It is this skill at tracking, more than any other single talent, that over the years has made Bushmen sought after by armies and hunters and farmers to pursue guerrillas, game, and poachers.

**T**ODAY THE HUNTERS return empty-handed. Game in Nyae Nyae has been decimated. In 1877 Hendrik van Zyl, an Afrikaans hunter, and his team of Bushman "shootboys" dispatched more than a hundred elephants here in a single day. Bantu-speaking herders of the Herero people, and white farmers too, culled antelope, which competed with their cattle for grazing. Hunting now provides only a small part of what Bushmen eat. Diet varies widely with conditions, but in a recent survey conducted in one Nyae Nyae village, game accounted for less than 20 percent of weekly nutrition. Government drought relief provided nearly 40 percent, and 35 percent was purchased with cash from pensions, craft sales, and wages. The remainder came from gardens and foraging.

A few days later, as the sun thaws the icy morning, I join a foraging expedition made up of the village women, who are going to gather *mangetti* nuts, which are about the size of hazelnuts and are a rich source of protein. The women wrap themselves in their hartebeest-skin cloaks, embroidered with bright bead circles, sling their babies on their backs, and set off through the bush at a deceptively fast loping stride. Some wear rough sandals made from car tires, but most are barefoot. Many of them have intricate tattoos on their faces: blue notches radiating out from each eye. They wade through the waving sea of grass, which is soft and blond in the low morning light. Soon they are rummaging in the foliage and poking in the earth with their digging sticks. As N $\neq$ aisa fills up her burlap side bag, she explains the uses of the various flora and fauna she is collecting. The root of one tree is good for curing you if you are coughing up blood. Another cures fever or flu. "And this," she

**My translator explains how they read the ground—"the same way you people read a book; the bush is our book."**





**Trading on the past,** *Bushmen erected a traditional village near the Nyae Nyae Conservancy, moved into grass huts, and received visitors from a local resort. In a good month tourists bring the village \$200—and the occasional soccer ball. The Bushmen had hoped for more.*

says, tugging up another weed, “is called the lucky plant. You burn it and put the ash on your face, and then every man will love you.”

Acacia beetles taken from branches have their legs plucked and are popped in the bag too. She reaches for the dappled shell of a tiny leopard tortoise that hangs from a bead belt around her waist, and, uncorking its hole, she empties a little snuff in the callused palm of her hand and takes a whiff.

We finally reach the mangetti grove. A small herd of elephants has recently been through, with all the destruction of a tornado, uprooting and pulverizing the trees. Still, by the time the women turn for home almost eight hours later, their collecting pouches are bulging. They adjust the babies strapped to their backs and head off, away from the setting sun, toward the distant thin smoke plumes of the village.

Once home the women tear the wings off the beetles and roast them in the coals of a small open fire for a few seconds each. I am presented with a handful, and I put one in my mouth and crunch down apprehensively. The beetle’s warm internal fluids flood my tongue, and I swallow hastily.

At night in the village there is often dancing around the fire, and sometimes this develops into a trance dance, one of the principal







elements of Bushman spirituality. Over the years missionaries have converted some Bushmen to Christianity but not those at Den/ui village. “We are traditionalists here,” the village leader explains. “We are not Christians. But we can talk to whoever the Christians talk to. It is all the same God; there are just different ways of talking to him.”

As the women and children sit around the fire clapping, the men shuffle around the blaze, pounding their feet into the dust, their flanks trembling under leather chaps. Little by little the rhythm of the clapping and the wordless chanting picks up. The ceremony, called the giraffe dance, is led by an old man, the resident shaman, an ostrich plume in his beaded headband and an ocher leather pouch flapping over his crotch. As he circles the fire, he eventually falls into a trance. Within this altered state of consciousness, the Bushmen believe, they can cure the sick and communicate with dead or absent relatives.

The mother of a sick village girl has asked the shaman to find out why she is ill, /Ai!ae/Aice tells me. The shaman holds the mother’s shoulders and presses his forehead to hers to pull in her thoughts. Other villagers rub *san*, a perfume made out of the roots of reeds, over the shaman’s body and throw handfuls of it into the fire, where it bursts into showers of tiny stars.

Suddenly the shaman leaves the flickering circle of fire and, elderly though he may be, leaps up into a nearby tree, where he squats, cackling and roaring at the crowd. He drops to the ground a few minutes later, his face cut and bleeding from the thorny branches, and continues dancing at a frenzied pace, shouting all the while up at the big cold sky.





**Short on patience,** an Intu Afrika manager meets a Bushman reenacting an antelope hunt (left). Before the hunter could get close enough to shoot the gemsbok with arrows, the manager killed it with a rifle, leaving the carcass for Bushmen to butcher. Advocates for Bushmen are urging the resort to share its revenues with the wider indigenous community.

“The problem,” announces the shaman, on behalf of a dead ancestor, “all began with the gemsbok. The one found dead near the village. You ate the meat, but you threw away the intestines and the stomach and the hooves. This was wasteful, and it angered the spirit, so now he will kill the girl. Everything, everything should be eaten up!” Trance dances often ease tensions and renew solidarity, but this warning that waste is bad is unusual—spirit conversations seldom spell out morals. The shaman assures the irate spirit that this mistake will not be made again. And with that the shaman collapses onto the chill red dust, his limbs twitching and palsied. The leader and others stroke his body until the trembling subsides.

**B**USHMAN CULTURE has attracted an increase not only in anthropological attention but also in ethnotourism, which some advocates believe might represent the best chance of preserving some remnants of Bushman cultural continuity. Organizations like WIMSA, Working Group of Indigenous Minorities in Southern Africa, have been trying to negotiate deals between Bushmen and tourist operators to prevent Bushmen from being exploited, as they have been in the past. Nyae Nyae is launching the beginnings of such an ethnotourism project. But existing ventures such as Intu Afrika, a white-owned commercial game reserve in southeastern Namibia that features a Bushman community, offer little hope of preserving the traditional ways, although they do keep alive a pride in Bushman cultural inheritance.

In this scenic corner of the desert, even after the rains, the russet earth



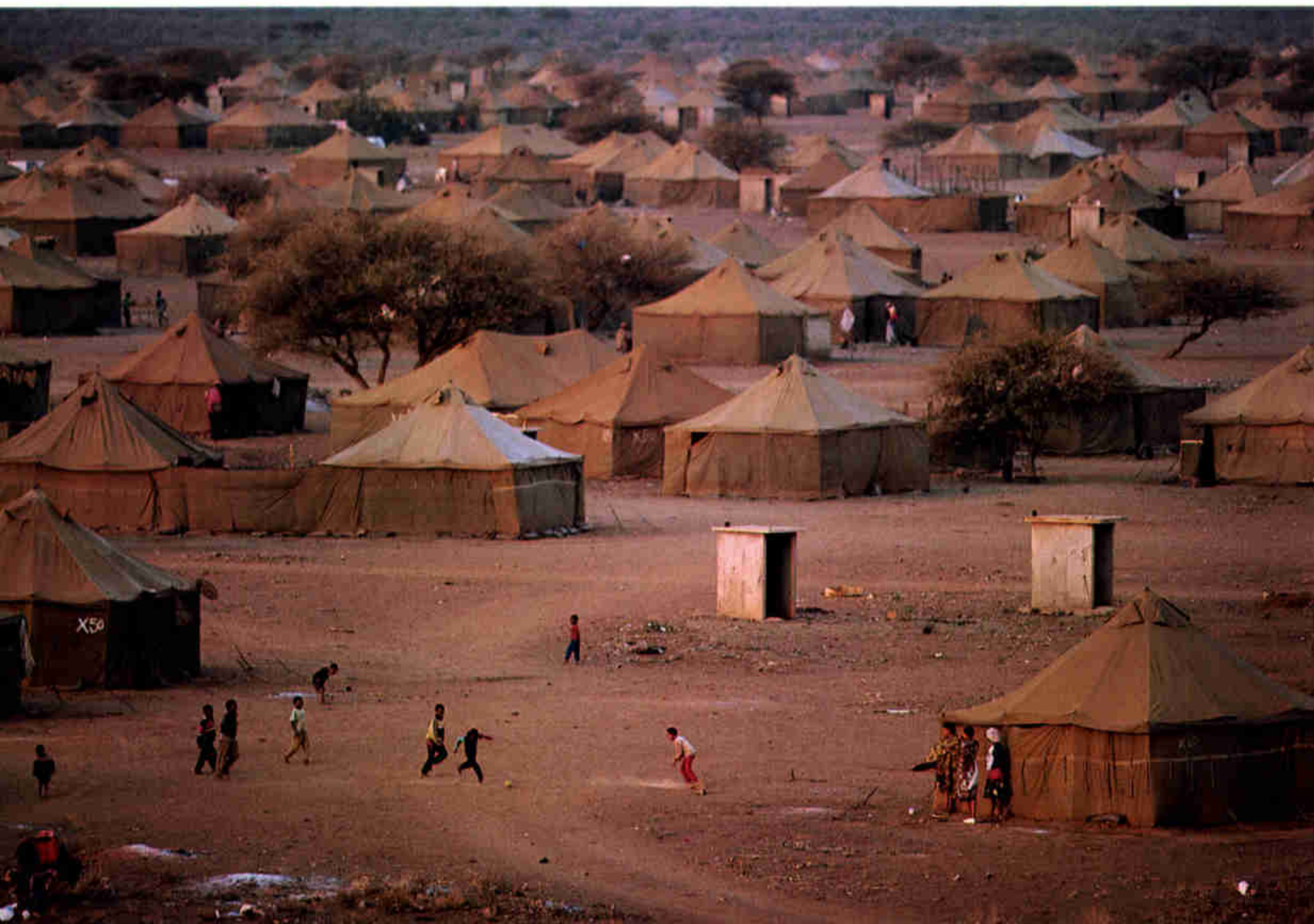


*Empowered by a trance, an old man lays hands on a girl to draw out what he sees as a spiritual sickness that drove her to hoard meat. Attended by tourists who pay to watch such ceremonies, this ritual helps sustain Bushman communities, bringing both money and healing.*









shows through the threadbare web of grass and lilac cattails. And cutting across the landscape, the long, narrow dunes rise up like great ripples in the sea of sand, guardians of the western edge of the Kalahari. Tourists arrive at Intu Afrika by the vanload to be entertained by a band of some 40 resident !Xóõ Bushmen.

This morning one of them, Alex, demonstrates how to set an ostrich trap. Though the tourists are swathed in jerseys against the winter chill, Alex wears only a buckskin cloak and a loincloth. Bushmen have a flair for mimicking wild animals, and Alex perfectly imitates the ostrich coming up to the bait and getting its head caught in the noose, desperately trying to wrench free, and finally succeeding, but only by decapitating itself.

The truth is that Alex and his colleagues no longer feed themselves by trapping ostriches. Instead they live on salaries and tips and by selling souvenirs. Every few weeks a game ranger shoots an antelope for them. I join Klein ("little" in Afrikaans) David and a group of four other Bushmen the next day to track gemsbok. Hilton Holm, the lodge manager, follows us in a Land Rover with his rifle. As the Bushmen jog up and down dune after dune, Klein David tells me their story. Most of these Bushmen come from Corridor 17, a small margin of land along the Botswana border that has become a dumping ground for Bushmen working on the surrounding white and Herero farms.

"There is no wildlife left there," Klein David complains, "even the hares are hunted out. There used to be much game there, when my grandfather was a boy. But the farmers who live nearby have fenced the land so we are caged in. If you move through someone else's land, they





### **Losing the peace**

*as well as the war, veterans who fought with the South African Army against Namibian independence languish in “a place of stones and thorns,” a tent city in Schmidtsdrift. At the camp clinic a girl bundles a child sick with TB against the cold. Originally from Angola and Namibia, the veterans hope for homes on a nearby farm.*

can arrest you and throw you in jail. Our old life is gone now, and we can never see it returning.

“Klein David is not my real name you know,” he says wistfully. “My Bushman name is Tchi!xo. It means ‘unlucky.’ They called me that because my father was a bad marksman; he kept missing with his arrows. But these days we don’t use our real names anymore. Missionaries came, and they gave us new names, names they could say easily. We didn’t use to have surnames either, but now we must have those too, to fill in forms. So my surname is Xamseb. It means ‘lion’ in the language of the Khoi: Tchi!xo Xamseb. Unlucky Lion.”

During his study of the 10,000 or so Bushmen who work on and off at the farms around Corridor 17, James Suzman, an anthropologist, torpedoed the belief that Bushmen ranged over great distances and simply moved to more remote areas when their lands were taken over. He found instead that wherever possible they stayed within areas they knew well, often no bigger than 10 or 20 square miles. “Even today,” he says, “they will stay on a white or Herero farm, whether employed there or not, however badly they’re treated, because it is their original territory and they have nowhere else to go.”

Unlike Corridor 17, Intu Afrika has been well stocked with game, and it’s not long before Holm brings down a gemsbok, a sleek black-and-white buck with V-shaped rapier-like horns. The Bushmen efficiently butcher it and pack it into sacks made of the intestines. They smear themselves with its blood—“to honor the spirit of the gemsbok,” says Klein David.

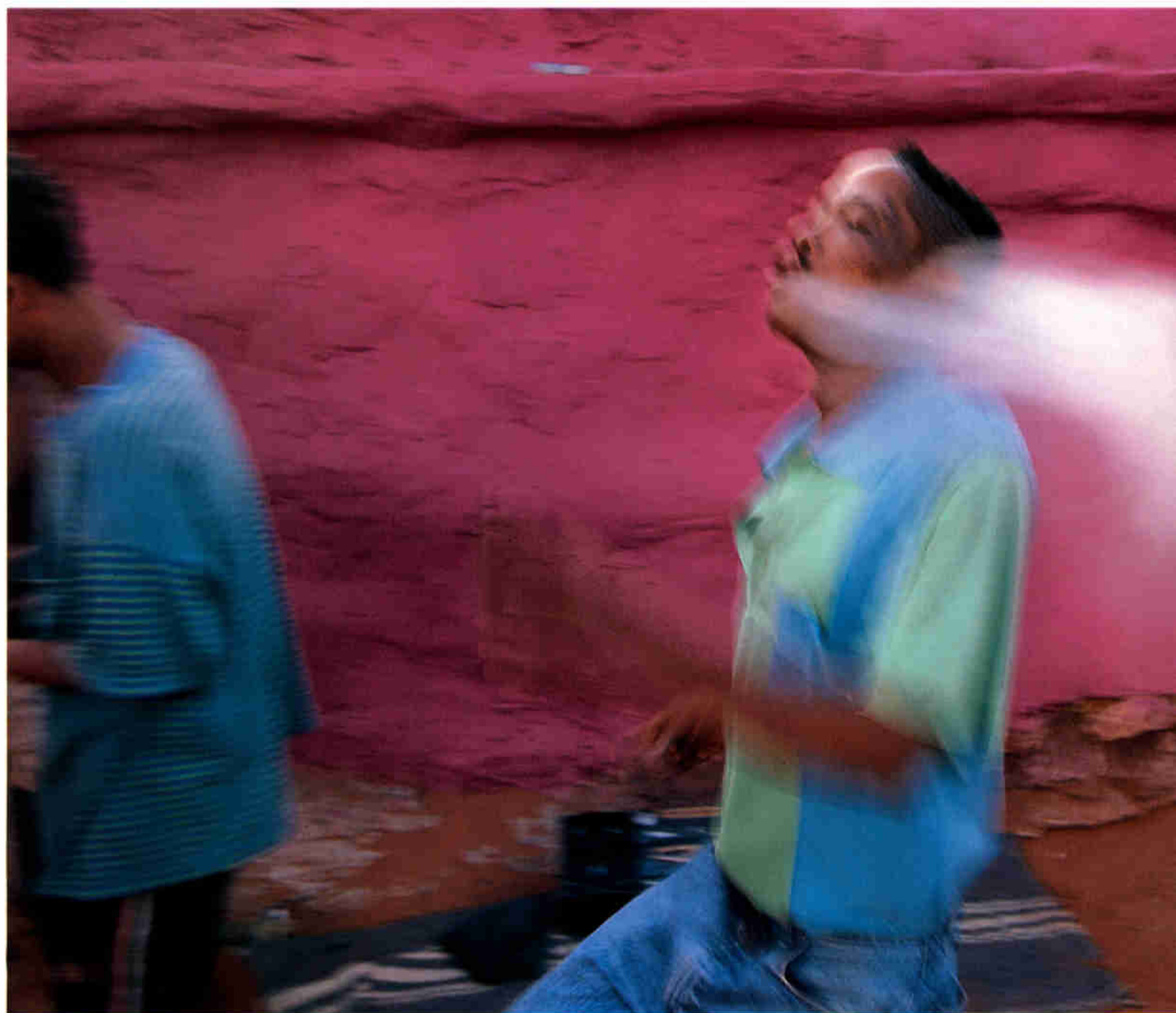
I return with him across a shimmering salt pan to the Bushmen’s



quarters, far from the prying eyes of the Intu Afrika tourists. Here, in a village named Twilight after the white farm on which it stands, Klein David and the others live in a cluster of dilapidated brick houses, in a yard festooned with garbage and old wheel rims and the carcasses of ruined bicycles. "The houses were perfectly good when we built them," says Holm. "But they've run the place down. They're not used to living in brick houses."

**F**ROM INTU AFRIKA I CROSS the border into Botswana, home to the largest surviving population of Bushmen, about 47,500. Most earn a living of sorts as ranch hands, but a few have managed to stay on their ancestral territory in what is now the Central Kalahari Game Reserve, Africa's third largest game park. It is a barren, foreboding place with no surface water for most of the year. In 1961, when the reserve was first established, George B. Silberbauer, a colonial Bushman officer, concluded that it could have a dual purpose: protecting indigenous Bushmen as well as wildlife, as long as the Bushmen hunted only by traditional methods. But since then the Botswana government has determined that the two mandates increasingly

**In South Africa by the 1980s it was widely believed there were no surviving Bushman groups in the country.**





**Gone up in smoke,**  
*a squatter exhales  
marijuana on the  
edge of a South Afri-  
can town. Bushmen  
call such settlements  
“places of death” and  
not without reason.  
Those forced off the  
land and into the  
modern world face  
drug and alcohol  
abuse, malnutrition,  
and killing disease.*



clash and has pursued a controversial policy of encouraging Bushmen to leave, although in the face of adverse international publicity, this is now under review.

Molapo, one of the last Bushman settlements within the Central Kalahari Game Reserve, is home to a dwindling number of //Gana Bushmen, about 150 now. Some have migrated to the government settlement of New Xade outside the park, lured by the promise of schools, clinics, fresh water, and a resettlement bonus of 5 cows or 15 goats each. To my surprise, I discover I'm not the only foreigner here. There is a Japanese researcher from the National Museum of Ethnology in Osaka. Kazunobu Ikeya has been studying this Bushman community periodically for more than ten years. As I arrive, he is making a video of a Bushman hacking with an ax at virtually the only tree in the area taller than head height. The rest have already been flattened for firewood.

“He is cutting a piece of wood with which to make a thumb piano,” guesses Ikeya, zooming in on the wood. A thumb piano consists of flattened metal strips of different lengths—the keys—attached to a wooden base. He points to an old scar on the trunk, evidence, he says, of the last thumb piano wood that was carved from the tree. It's a good example of how the Bushmen carry out natural conservation, keeping this tree alive to use it again. But now the Bushman's vigorous ax strokes are getting perilously close to felling the music tree, and indeed barely has Ikeya spoken than it comes crashing down. It seems the present need for firewood is more pressing than future desire for thumb pianos.

Although the people of Molapo are living on their ancestral land, they are no longer living the life of the legendary desert-adapted Bushmen of old. Their water comes not from tubers in the ground but mainly from a large plastic water tank on an elevated platform. It is topped up monthly by a government water bowser that chugs in from Mothomelo. They have herds of goats here too, and donkeys. They hunt on horseback with spears and packs of dogs instead of on foot with bows and arrows. Deliveries of government food bolster their diet.

In the absence of Roy Sesana, a village resident and the president of First People of the Kalahari, a lobbying group that campaigns for Bushman rights to the Central Kalahari Game Reserve, Kobou, an old Bushman with a deeply lined face, speaks for the settlement. Kobou sits with the others, wearing a thick woolly ski cap and laceless army boots.

“The government comes many times to persuade us to move to New Xade,” he says. “We refused, because this is our home, and we didn't want the money.” Kobou says they have never been threatened, but he admits that if the government ceased water deliveries, “we would have to move or die. We could survive on wild melons and roots and natural pools but only for three months of the year during the wet season.”

**I**T WAS IN SOUTH AFRICA that settlers, aided over the years by various epidemics, carried out the most complete reduction of Bushmen. By the 1980s it was widely believed there were no surviving Bushman groups in the country. But then, following the collapse of apartheid, the scattered remnants of the ≠Khomani Bushmen, about 250 of them, were located almost by accident on farms and in squatter camps around Rietfontein.

Roger Chennells, a lawyer for the South African San Institute (SASI),





established in 1996, is mining the new South African constitution to reclaim a large tract of land in Northern Cape Province for the ≠Khomani, a tract that includes the former Kalahari Gemsbok National Park, now absorbed into the Kgalagadi Transfrontier Park. I accompanied him to the red dunes and camel thorn trees of the southern Kalahari, to the settlement of Welkom, where many of the ≠Khomani Bushmen had gathered at Chennells' request to choose community leaders. It was a noisy affair conducted entirely in Afrikaans, as Chennells patiently outlined the alien concept of voting to the high-spirited group.

Petrus Vaalbooi, who was elected a leader, asked his audience, "If a lioness gives birth, will you help me to steal the cub?" It was his way of warning them that they faced big problems ahead.

A few months later, in early 2000, the South African government officially turned over a parcel of land to them just south of the reserve. They still face immense challenges in developing it, either for tourism or farming, but the experience of these South African San has revitalized the struggle all Bushmen confront for community recognition and land rights.

Although South Africa has only this tiny band of indigenous Bushmen, it is still home to the largest Bushman settlement on Earth, and perhaps the most distressing, at a place called Schmidtsdrift. More than 4,300 Bushmen originally from Angola and Namibia are now marooned at Schmidtsdrift, an hour's drive west of Kimberley, the provincial capital of the Northern Cape. It is a cheerless spot that smells of desolation. Lines of military tents, about 1,900 in all, stand on an open, windswept, stony slope that leads down to the bank of the Vaal River, carefully





### **Imitation rock art**

*and souvenir bows are sold at South Africa's Kagga Kamma resort. The seller makes about \$30 a month, far more than most Bushmen.*

*In neighboring*

*Namibia, a woman from the Herero ethnic group relaxes*

*while her Bushman servant irons. For such domestic work the servant will receive food, shelter, clothes, and pocket money.*

segregated between two Bushman groups, the !Xû and the Khwe, who dislike each other intensely. Since 1990 this has been the temporary home of a Bushman battalion of the South African Army. The battalion itself was disbanded in 1994 after the end of apartheid, but the Bushmen simply refused to leave: They had nowhere to go.

Ironically Schmidtsdrift is probably the Bushmen's most affluent community. Many of the former soldiers continue to draw pensions, and there is both an elementary and a high school, as well as a fully staffed health clinic. But the rampant use of alcohol and marijuana is a sign of the dislocation and loss in Schmidtsdrift, palliatives against a world that has overwhelmed these people. In the camp store the first section you come to through the turnstile is the liquor department. It is starkly utilitarian, carrying only bottom-of-the-line, top-of-the-alcohol-content brands, such as Diamond Fields Late Harvest, a white wine that comes in a silver foil bag, stripped even of the nicety of a bottle.

At the clinic the army doctor tells me that children as young as 12 are addicted to alcohol. The doctor goes on to say that TB has long been the number one killer. Bushmen still resort to traditional medicine when they fall ill, and only when that fails do they come to the clinic. Often it's too late by then. Bushmen are deeply suspicious of Western medicine, and the doctor admits he cannot cross the cultural barrier.

A wailing siren marks lunchtime at the camp school, and more than 1,600 children line up for their meal—a thick soup ladled into bowls, and a chunk of bread. This is the only daily sustenance for many of them, and it ensures that they continue to attend classes. No classes, no soup.









*A barbed clothesline frames a new settlement on land South Africa granted to a Bushman group in the Kalahari. Soon after arriving in 1999, the Bushmen hunted out much of the game, but they now conserve what remains in hopes tourists will stop by on their way to a nearby game park.*



The leader of the !Xû Traditional Council at Schmidtsdrift is Staff Sgt. Mario Mahongo, a !Xû Bushman. He is chairman of the !Xû & Khwe Communal Property Association, a consultative group that represents the interests of both the !Xû and the Khwe. The association is planning to move the whole community to a nearby farm, where there would be permanent housing, provided by the government and private foundations, and more opportunities, such as making and selling traditional craft items.

Mahongo is a small man with a mustache, tortoiseshell sunglasses, camouflage fatigues, and brown army boots. He sits in a mobile home that serves as his office in the middle of the camp. Behind him the wall is lined with inspirational posters. Like many of the men here he began his military career in the war for Angolan independence, fighting on the side of the Portuguese colonials.

“Between us and the blacks there was always a lot of conflict,” Mahongo says. “They used my people as slaves. The Portuguese saw this, and when they started having their own conflict with the blacks, they approached us and said, ‘Let’s get together, with a common goal.’”

After the Portuguese left Angola in 1975, South Africa recruited the Bushmen to fight pro-independence guerrillas in Namibia. When

### **Shadow of a people:**

*A boy’s silhouette darkens a wall in Welkom, South Africa, where his band squatted for 16 years. Only now are governments hearing the plea of a Bushman half a century ago: “Listen to . . . a race which is very tired of running away. . . . Give us a piece of land of our own.”*





history repeated itself and Namibia also became independent, the Bushmen feared reprisals and fled again, to South Africa.

"We would like to go back to a time when there were no borders, no fences," says Mahongo. "But here in South Africa you can forget about that. Everything here is parceled up and fenced. At least in Angola there are still some wild areas, even in Namibia too. But not here. My heart is still in Angola—but that country is now a foreign place to my children. My home area is still gripped by war, even after all these years.

"A lot of our culture," he says, "is lost in our lives—the old stories that were told by mothers and fathers who would go into the bush and then return to tell the others what they had seen. The problem now is that no one goes out and does anything, so we have no stories to tell our children. We have nothing to pass on. In the old days we had to make a musical instrument and sing along to it. Now we just go to town and buy a tape and listen to that."

**B**ATISDA SALVADORE, LIAISON OFFICER for the !Xú & Khwe association, takes me on a tour of the camp. He is the son of a Portuguese father and a !Xú mother. "The government thought a Bushman is a Bushman, so they put us all together," he says. "But there are two different tribes here, and we don't get along. The problem is that the Khwe eat more than the !Xú, and they pursue our wives. Some of us think they are not real Bushmen at all."

Indeed the Khwe do look Bantu. They are taller and blacker, and they lack the slightly Asian look of the !Xú that conforms with the Western stereotype of the Bushmen.

I stroll down to the Vaal River with Salvadore. On the other side it is a different world, a world of white-owned farms, intensively tended, with green alfalfa fields under irrigation. Some of the !Xú Bushmen have moved down here to the riverside, where they live in small lean-to shelters. They swim naked in the shallows using mosquito nets and perforated shade cloth to trap catfish.

"Why did you move from the main camp?" I ask one family who are regarding us suspiciously. "We hated the noise and the drunks," says Kanguia Mundinda, a wizened middle-aged woman. "We must keep moving—it is our way."

As I leave Schmidtsdrift, Mahongo comes over to say good-bye. "Pity us poor Bushmen," he entreats me. "Pity us who have so many problems facing us in this world down here. We Bushmen, we were the first people here, so how come we are the last in line to get anything? When people see we are a gentle people, they just walk on us. We have to find the strength to make a place for ourselves in this world. Otherwise there will soon be no more of us. We will all be gone. And so will our memories. Only our paintings will remain behind to remind you of us."

But as the traditional lifestyle of the Bushmen of southern Africa retreats behind the glass of the museum diorama, Mahongo's entreaty already sounds like a plea from the past. As the remaining Bushmen struggle to adapt to the changes around them, perhaps the most that can be saved is the legacy of their cultural memory, in particular their extraordinary intimacy with nature. □

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**By David Lewis-Williams**  
**Photographs by Kenneth Garrett**

WHEN EUROPEANS FIRST ENCOUNTERED rock art of the San people, or Bushmen, in southern Africa some 350 years ago, they considered it primitive and crude, like the people who made it. They were just "Bushman paintings," two-dimensional accounts of hunting and fighting and daily life. Twentieth-century scholars had much more respect for the aesthetics of the paintings—often finely detailed and exquisitely colored—but many also viewed them largely as narrative accounts of hunter-gatherer life. A closer look in recent years has yielded another picture altogether. For the San, rock paintings weren't just representations of life; they were also repositories of it. When shamans painted an eland (right), they didn't just pay homage to a sacred animal; they also harnessed its essence. They put paint to rock and opened portals to the spirit world. In 1993, in a shallow cave in South Africa's Drakensberg mountains, my colleagues Geoff Blundell and Sven Ouzman found a painting unlike anything else I've seen in my 40 years studying San art—a densely layered, 20-foot-long mural (foldout pages) that gives us fresh insight into the spirit world of the Bushmen.

# Paintings of the Spirit

*Rock Art Opens a New Window  
Into the Bushman World*



**"Pity us poor Bushmen.  
... We were the first  
people here, so how come  
we are the last in line  
to get anything?"**



*These aren't "pictures" in the Western sense of the word. They are things in themselves—they've got their own power, their own existence.*



### Painting Through the Veil



FOR YEARS RESEARCHERS used what I call the “gaze and guess” approach to interpreting rock art—look at a painting and surmise what it seems to be about. Without understanding the people who made the art, that method yields predictably wrong interpretations. It’s like trying to understand

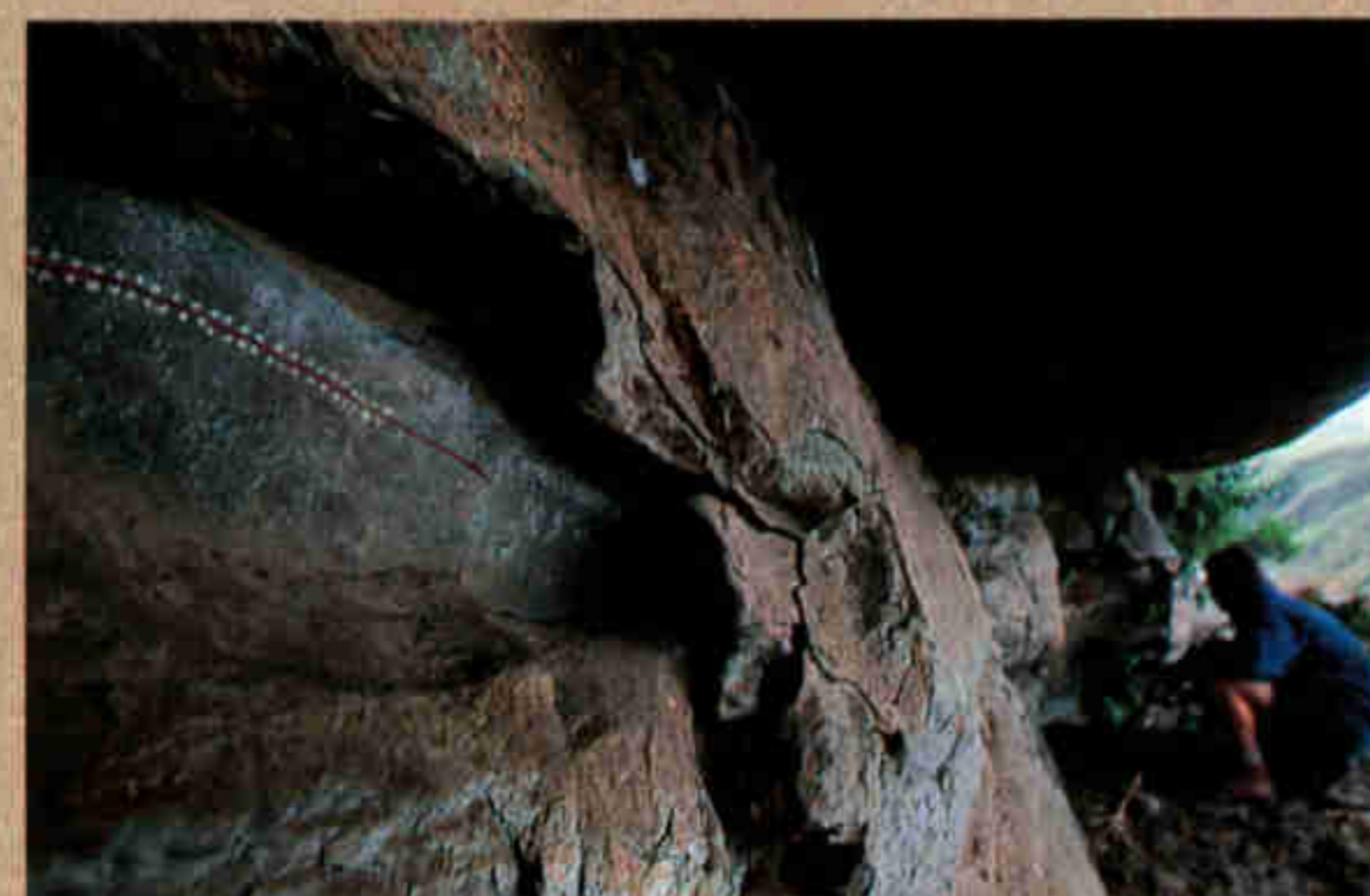
Shakespeare without having a firm grasp of the English language.

At first glance this painting (photograph, far right; the illustration above is based on a tracing) looks like a jumble of antelope and stick figures. But the panel, which has at least five layers that may span hundreds of years—is notoriously difficult to date—is pregnant with meaning, with a grammar and syntax that we’re just beginning to decode.

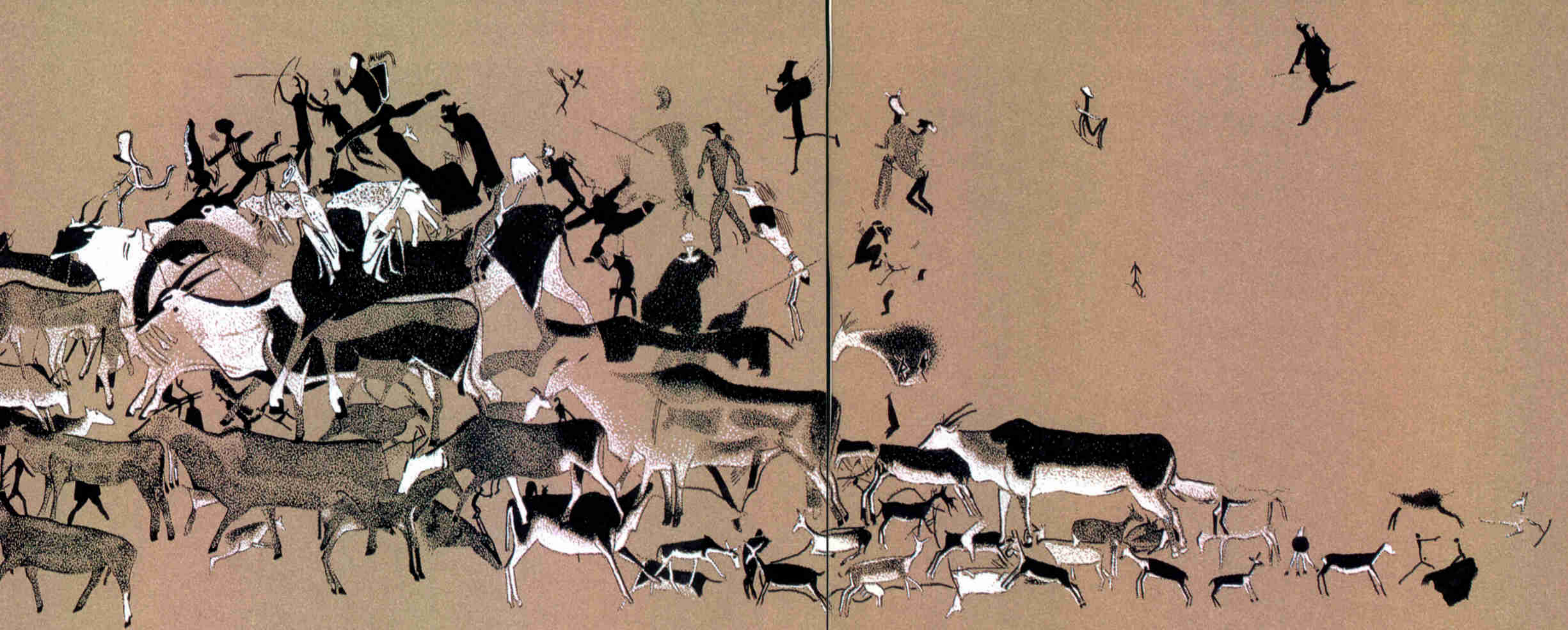
Our baseline understanding of San art comes from long-neglected ethnographic work done by Wilhelm Bleek and Lucy Lloyd in the 1870s.

For more than 25,000 years hunter-gatherers roamed the Drakensberg mountains (above left) and much of

southern Africa. In the 18th and 19th centuries their culture was all but extinguished by European immigrants, who derogatorily called the people Bushmen (many anthropologists prefer “San,” a Khoi term meaning “outsider”). Before San painting became a forgotten art, Bleek and Lloyd extensively interviewed San who knew about the painting rituals,







ART BY SHAWN GOULD; SOURCE: GEOFF BLUNDELL

learning that the art centered on, as Bleek put it, "the ideas which most deeply moved the Bushman mind, and filled it with religious feelings."

That reference to religious feelings explains the prominence of eland; they were reservoirs of spiritual power, the favored animal of the main San god. One looks at this art and wonders, Do the eland create an ambience that locates god? For the rock was not simply a canvas but also a veil between the material and spirit worlds, and paintings helped pierce that veil. At many San art sites, a red line (photograph, left) weaves in and out of the rock, connecting physical places to each other and to the spirit world.







CHRIS JOHNS, NGS

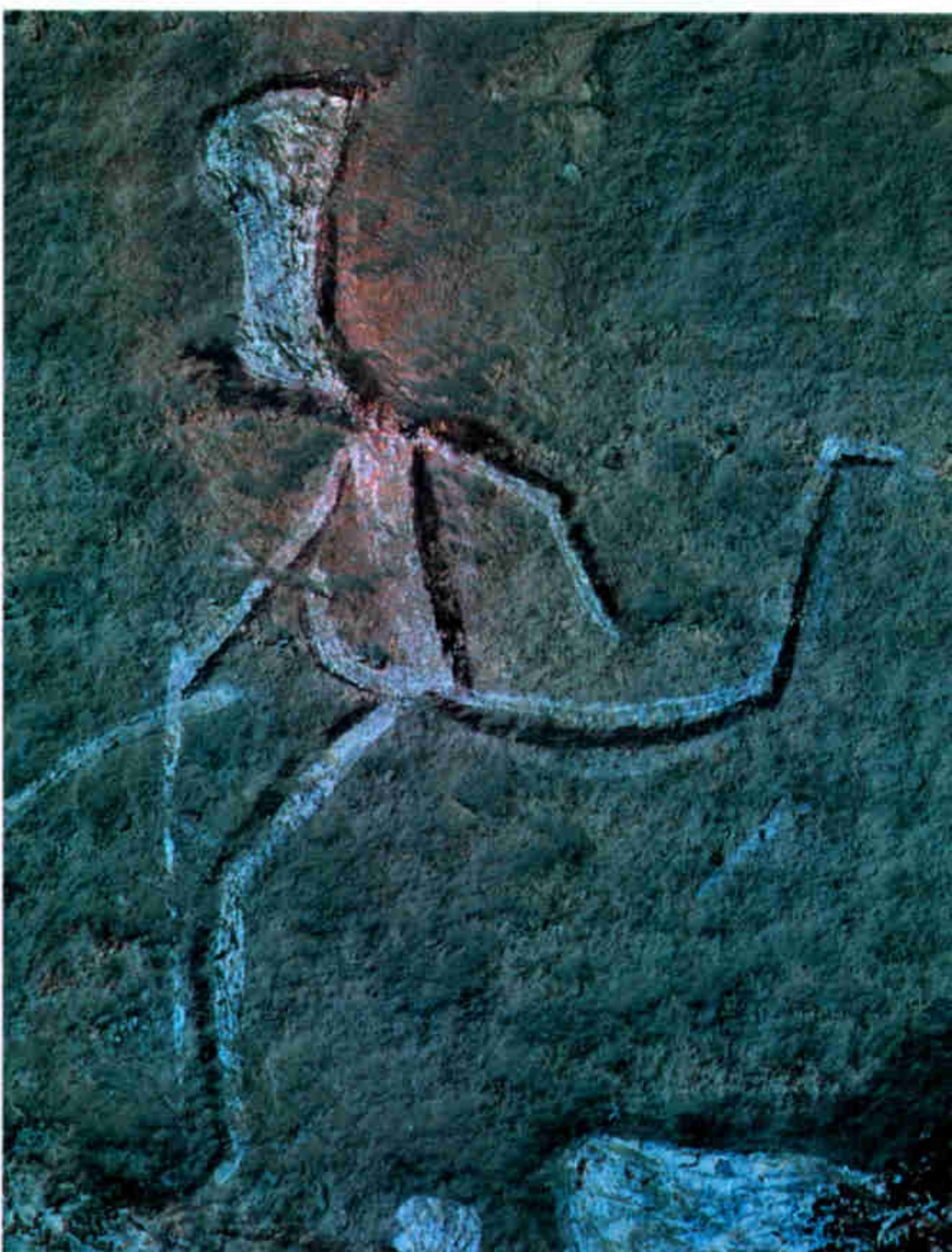
## Boiling Into the Spirit World

THOUGH BUSHMEN STOPPED PAINTING ROCKS a century ago, some groups in the Kalahari Desert still practice trance rituals (above) that evoke the San paintings. In all-night ceremonies women clap and sing as men dance around the fire, hyperventilating, until their “potency”—their spiritual power—begins to “boil” within them. A boiling shaman will usually bend over in pain, sometimes bleeding from the nose (far right, top), as he enters the spirit world. He may transform into an animal (below and right, top and bottom), tapping its power to cure the sick, make rain, or control prey animals. Even when human figures in San art are not half animal, they are often surreal, with irregular heads (far right, bottom) that suggest an altered state of being.

San artists almost surely didn’t paint until after a trance; then, if they were like today’s shamans, they spent hours recounting their experience. “This is what I looked like in the spirit world,” they might say, as they painted a portal to that place of being. □









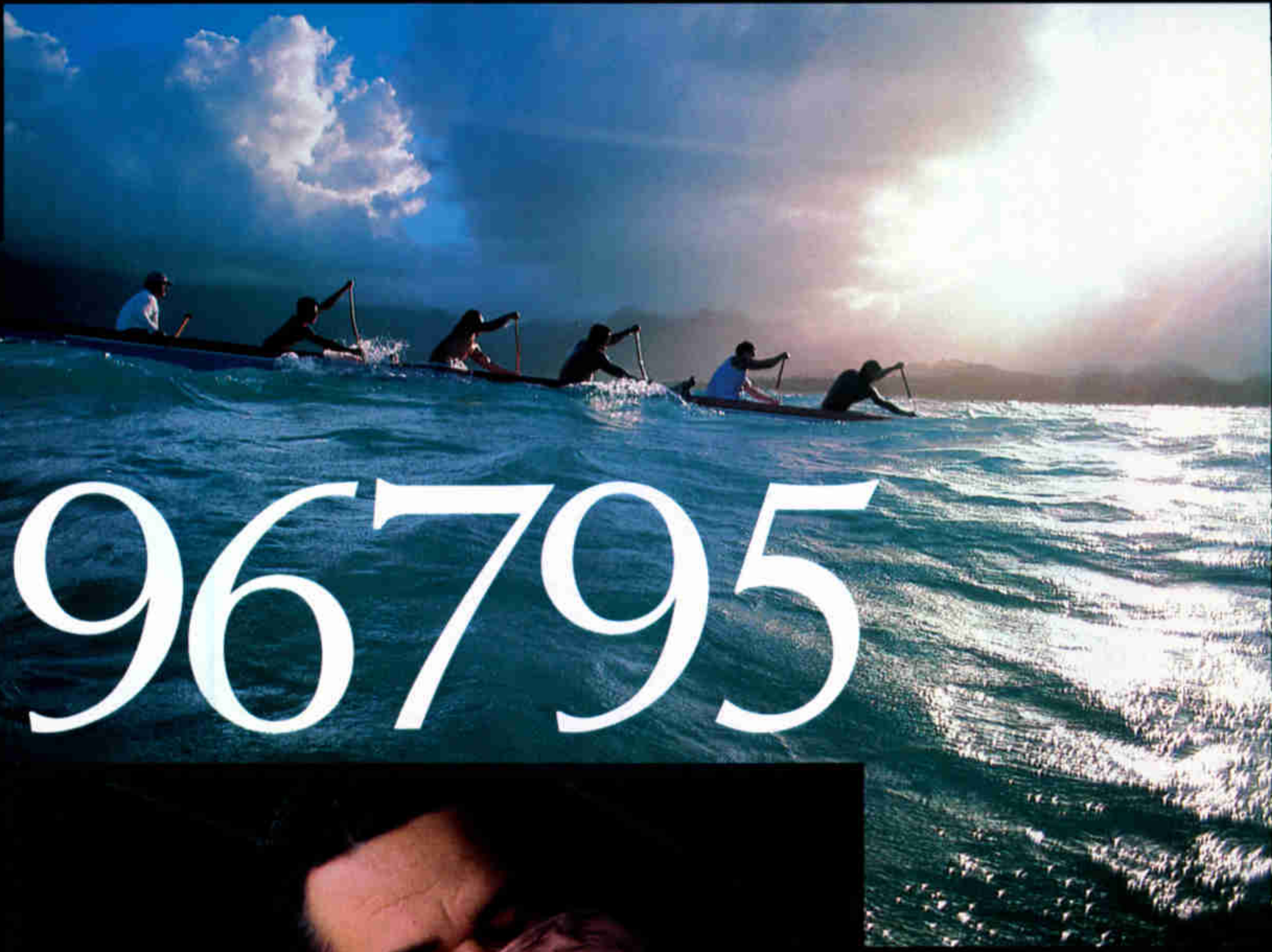
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The  
Hawaiians'  
Hawaii

BY TOM O'NEILL NATIONAL GEOGRAPHIC SENIOR WRITER  
PHOTOGRAPHS BY JODI COBB NATIONAL GEOGRAPHIC PHOTOGRAPHER





A woman, Christy Kalama, is captured in a hula performance on a beach. She is wearing a black halter-neck bikini top and a red sarong with a white floral pattern. Her arms are raised high, and she has a focused expression. The background shows a clear blue sky, a white sandy beach, and turquoise water. In the distance, another person is visible performing hula. The text is positioned in the upper right corner of the image.

Moved by tradition, Christy Kalama practices hula on the beach. Paddlers perfect their racing strokes in an outrigger canoe. For musician Kurt Kipapa, father of ten, baby love is a number one hit.



“Make a difference!” shouted coach Nani Akeo from the stern, her command nearly lost in the *huzz* of panting breath and slapping waves. The outrigger canoe, a 40-foot sluice of fiberglass, sped through the clear waters off Oahu’s windward coast. The team of six, members of the Over 45 Women’s Crew for the Waimanalo Canoe Club, were driving their paddles rhythmically into the water.

Few of those paddlers or the other club members practicing for the weekend’s island-wide race were thinking just then about big-picture issues like cultural survival or community pride. But for Auntie Nani, as she’s known to the club, paddling—or doing anything in the ocean for that matter—leads to bigger, better things, namely making her town of Waimanalo a happier place to live.



“Take a break,” Nani, a 57-year-old school custodian, told her crew. “Enjoy the scenery. Look at your beautiful village.”

There it is: Waimanalo. The town stretches out lazily along the coast like a sleeping hound, a three-mile reach of homes, shops, and parks penned between ridges of the cloud-catching Koolau Range. Waimanalo is only a half hour’s drive from Honolulu, and yet it feels like another planet. The village faces a long, curving white-sand beach, one so luscious that it is used as a backdrop for the television series *Baywatch Hawai‘i*.

Surrounded by suburbs, Waimanalo residents like to say: “We live in the country.” Behind the village climb acres of farmland, most of it given to raising ornamental plants. People keep horses and chickens. The salty trade winds spice the air even in the foothills.

Mohala Pokini sensed a difference when she moved to Waimanalo from a Honolulu suburb seven years ago. “I’d never seen so many Hawaiians in one place,” said Mohala, a school tutor and native Hawaiian herself. An estimated half of the roughly 9,000 inhabitants in zip code 96795 claim at least 50 percent Hawaiian blood, the legal definition of a native for the Hawaiian homelands program. Many of these native

**Lucky Waimanalo:**

**A sheltering reef and soft three-mile beach—one of the longest undeveloped strands on Oahu—give the town a blissful front yard.**



96795

**POPULATION:** 9,057

**MEANING OF WAIMANALO:**

“Potable water”

**MOST FAMOUS ADDRESS:**

41-505 Kalanianaʻole Highway, home of Tom Selleck’s character in *Magnum, P.I.*

**MOST UNWANTED**

**VISITOR:** Pilot of a Japanese midget submarine, captured on the beach December 8, 1941—America’s first prisoner in World War II

**LARGEST WAIST SIZE OF SWIM TRUNKS AT POINT**

**BREAK SURF SHOP:** 56

**MOST FAMOUS HOMEBOY:**

Akebono, one of Japan’s grand champion sumo wrestlers, who grew up here as Chad Rowan

**AVERAGE NUMBER OF**

**DAYS A YEAR WARM**

**ENOUGH TO SWIM:** 365



Hawaiians live in the central village on homestead lots. The program entitles them to lease the land and provides low-cost loans for building.

After an *aloha* and kiss on the cheek, Mohala had invited me into her airy one-story house, typical of Waimanalo's dwellings. Her hair pulled back in a ponytail, she laughed and said she had conformed by dressing 'alu'alu—casual—in shorts and T-shirt. "I'm half Hawaiian, but in the city I was raised Oriental and Caucasian style," Mohala said. "I guess I came off as aggressive. I had to blend here—pull back and relax."

Hawaiian consciousness takes a variety of forms in Waimanalo. Villagers paddle outrigger canoes and grow taro and other traditional staples. An increasing number speak Hawaiian, a language discouraged in schools during pre-statehood days, and some locals even agitate for an independent Hawaiian nation.

One of the first things drivers see when approaching the village on the coast road from Honolulu is a large faded state flag hanging upside down in the "distress" position. It's a defiant symbol of the Hawaiian sovereignty movement, a heated subject in Waimanalo's neighborhoods.

Six years earlier a few hundred residents established a protest community in the foothills. They vowed to immerse themselves in traditional Hawaiian culture and to fight for nationhood, however improbable the odds.

"96795 is a stronghold for the whole movement," said Dennis Kanahale, a settlement leader. He showed me the reclusive camp of small homes ringed around a grassy commons. "To live here, you have to do your share of work and believe in the truth of history, that our land was stolen from us," he said. "We're telling our kids that history is more than Columbus and cowboys."

**Leaving the blue behind, a flame-haired surfer heads home from Makapuu Beach. Smoking fish and a few ukulele tunes season the evening for the Ka'ano'i brothers.**







**Baring his loyalty to the past, a native Hawaiian wears a tattoo of a traditional warrior's mask. The thrills of the present engage a surfer riding the waves at Makapuu.**

Politics and history usually bow to more easygoing subjects when all across Waimanalo friends and family collect in the cool of evening to eat dinner, potluck style, and to “talk story.” Abe Aiona, a retired fireman, waved me into his yard to sit at a picnic table loaded with raw tuna, octopus salad, and a bowl of *poi*, a thick gray paste made from taro root. Guests of all ages drifted in; the air smelled of diaper and barbecue. Talk this night went the rounds from who’s marrying whom, the threat of a four-lane road in town, and weird ghost sightings at the firehouse.

Voices dropped when the subject veered unexpectedly to Waimanalo’s rough edges. Drugs have ravaged many families, teenage pregnancies are high, homeless people camp on the beach. The grown-ups sighed: What can be done?

Down at the beach people were fighting back. They were reintroducing their neighbors to Waimanalo’s most saving resource, the sea.

Once a week Dr. Patrice Ming-Lei Tim Sing (known to all as Ming) gathers overweight women, some of them 300 pounds or more, to exercise in warm, chest-deep water. “The ocean is healing,” said Ming, a pediatrician and internist at the local health clinic. “Some of these women had not been in the ocean for 30 years.” Pointing to her subjects bouncing like corks in the water, the superfit Ming gave her diagnosis: “Blood sugar is down, weight is down, self-esteem is up.”

Nothing has energized Waimanalo more visibly than the revived canoe club. Its membership has shot up in four years from a couple dozen stalwarts to more than a hundred paddlers, from fourth graders to grandparents. “We wanted to get kids off the streets and bring activity back to Waimanalo,” said Nani, letting up on her team as the various crews and their canoes glided back to shore after practice. “Bonding with the ocean is such a positive thing, such a spiritual thing.”

The paddlers now pulled the canoes onto the beach, shook out their weary arms, and gave high-fives all around. Before heading to their homes, everyone gathered in a circle, hands piled up in the center, and belted out in Hawaiian their one-two-three cheer: “*‘Ekahi, ‘Elua, ‘Ekolu, WAIMANALO!*” □

**MORE INFORMATION**

**ON OUR WEBSITE** There’s more on 96795 at [nationalgeographic.com/ngm/0102](http://nationalgeographic.com/ngm/0102).

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# Final Edit



## THE ANDES

### Red-hot Luck

Tungurahua was stirring, but clouds had blocked the view of the volcano for weeks. Photographer Pablo Corral Vega had traveled a hundred miles south of his home in Quito, Ecuador, to try to get a shot. Perched on a steep outcrop, he waited blindly. Suddenly the sky cleared. As he opened the shutter, glowing rocks and lava erupted with a roar from the blazing crater and rolled down the slopes. Almost simultaneously a thunderbolt backlit one side of the cone. "It was a real gift," he says. "The clouds covered the volcano again in seconds."

Some 25,000 people living around Tungurahua were evacuated to safety. But in Quito 1.5 million live under the threat of smoking Guagua Pichincha (page 20). To illustrate the volcanic hazards of the Andes for Corral Vega's story, clear danger won out over beauty.

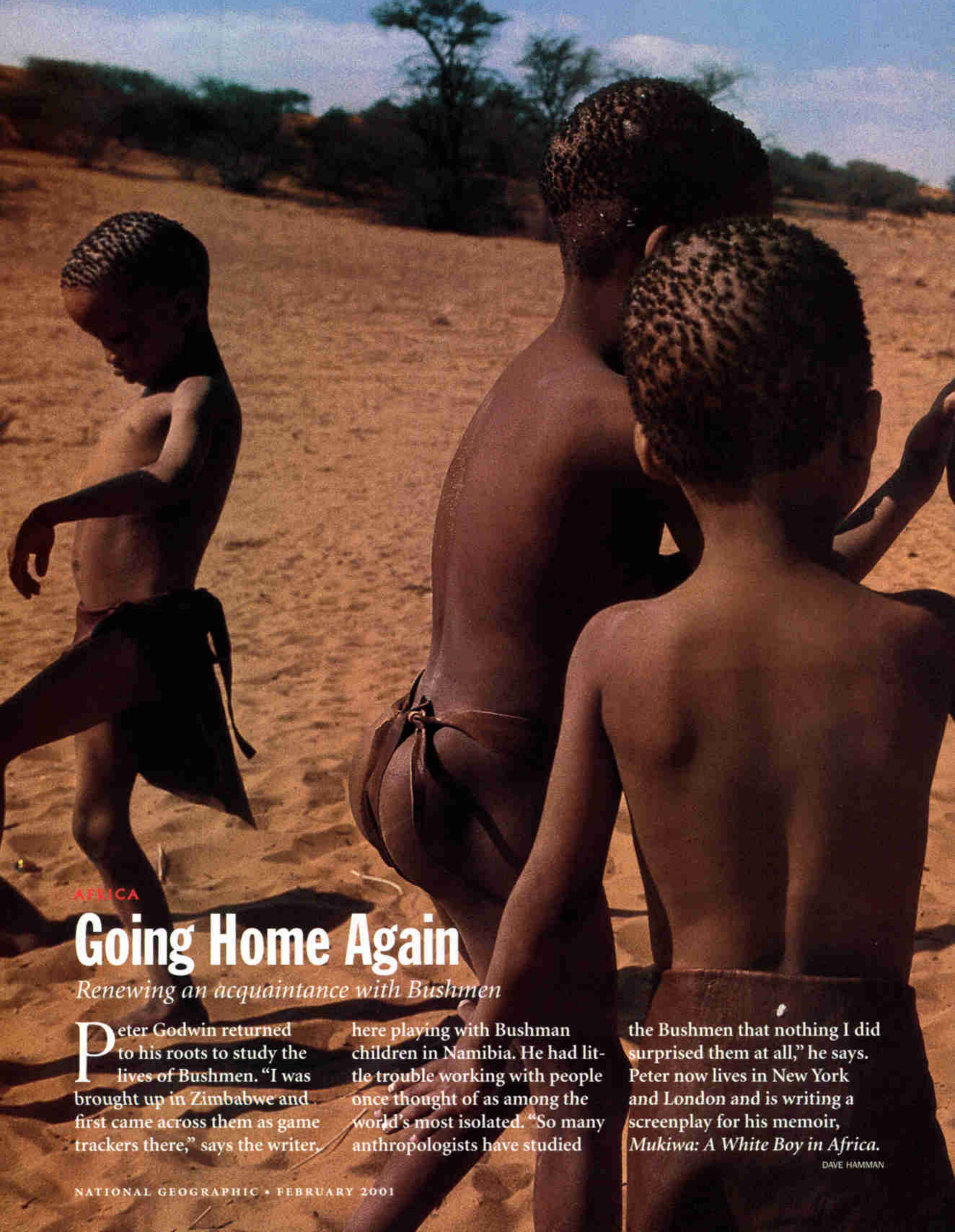
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# ON ASSI

ON THE ROAD, IN THE FIELD,



AFRICA

## Going Home Again

*Renewing an acquaintance with Bushmen*

**P**eter Godwin returned to his roots to study the lives of Bushmen. "I was brought up in Zimbabwe and first came across them as game trackers there," says the writer,

here playing with Bushman children in Namibia. He had little trouble working with people once thought of as among the world's most isolated. "So many anthropologists have studied

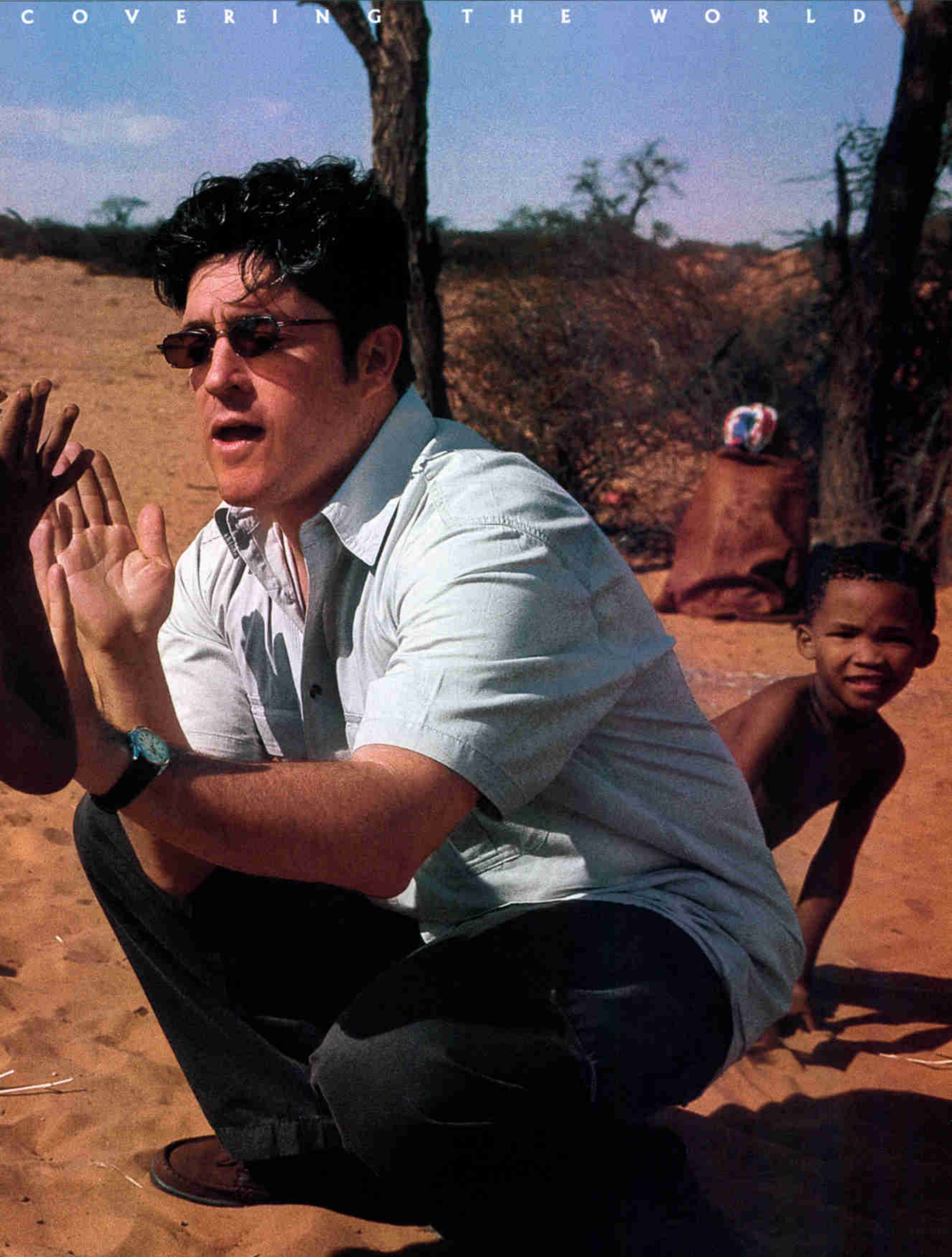
the Bushmen that nothing I did surprised them at all," he says. Peter now lives in New York and London and is writing a screenplay for his memoir, *Mukiwa: A White Boy in Africa*.

DAVE HAMMAN



# GOVERNMENT

C O V E R I N G T H E W O R L D





## ECUADOR

## An Andes High

When Pablo Corral Vega was six years old, he received a camera for Christmas. "It was then that photography became my companion and my friend," he says. "The camera is an excuse to see the world with wonder and curiosity, to pay attention to everything that surrounds me."

A lawyer in his native Ecuador, Pablo gave up that career when he began his Andes trek in 1994. "I felt the need to photograph my people and culture from



KENT J. KOBERSTEEN, NGS STAFF

"inside," he says, including this Corpus Christi festival (above) celebrated by the Salasaca Indians of central Ecuador. An expanded version of Pablo's

photographic journey—with text by Peruvian writer Mario Vargas Llosa—will be published this fall in a National Geographic Society book, *The Andes*.

## WORLDWIDE



RANDY OLSON

Sitting in a duck hunter's boat in the New Jersey Meadowlands, photographer **Melissa Farlow** (above) was struck by the incongruities: "This area is so dense, so urban, yet I feel like I'm in the wilds. I could be in any wetlands anywhere. But off in the distance over the hunter's shoulder are the Empire State Building, lines and lines of headlights heading out of Manhattan, and, in the other direction, the glow of a Rolling Stones concert at Giants Stadium." She found the people of nearby Secaucus charming and warm. "I went to church

with them, to the school prom, to dance recitals," she says. "People would honk at me on the street, just like in a small Midwest town."

"I started collecting butterflies and moths when I was five and never outgrew it," says **David Hawks**. David first became aware of jewel scarabs as a boy of 14 on a family trip to the mountains of southeastern Arizona. Now a staff research associate in the entomology department of the University of California at Riverside—"I'm not a professional photographer; I'm a for-fun photographer"—he's made nearly 20 trips to Central America in search of the beetles with the "fantastic appearance."

On his first full day in Waimanalo, Hawaii, **Tom O'Neill** wandered down to the ocean, where he met the coaches of the community's outrigger canoe racing teams. "They said the only way to understand what it's like, the hard work and teamwork and pleasure, is to paddle with them," recalls Tom (below, second from left). "So I did. After a while I took pride in showing them my blisters. I think they humored me by moving me around to different teams. I'm a good paddler, but I provided strength, not finesse." On another day he ventured out with fishermen into the ocean beyond the close-in reef. "The swells were so high, I felt green and got good and seasick," Tom says. "They nicknamed me Perfect Storm."



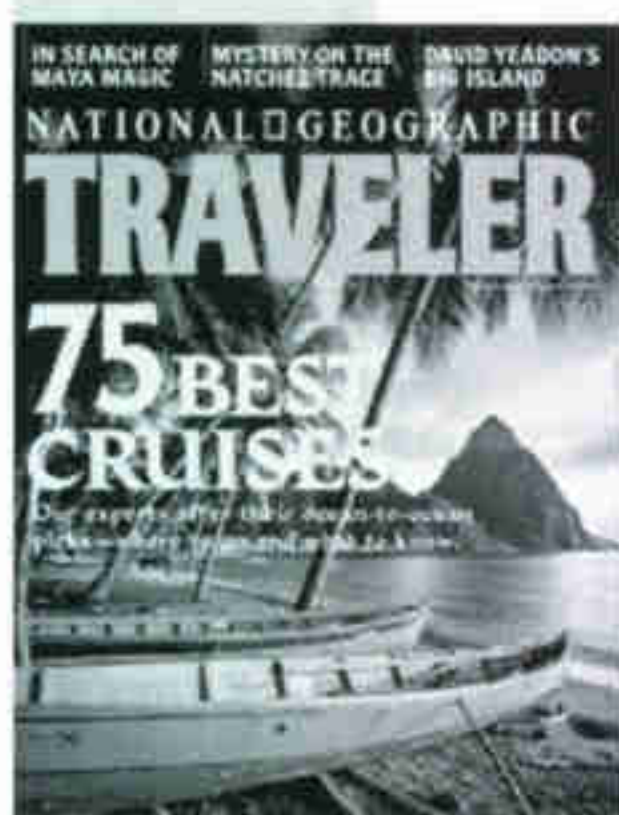
NATIONAL GEOGRAPHIC PHOTOGRAPHER JODI COBB

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# Flashback



RICHARD H. STEWART

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## Tan Line

“Sun-baked mermaids at Honolulu’s celebrated beach line up their surfboards just before a swift dash on the crest of a curling wave,” read the caption for this photo of Waikiki tourists from our October 1938 article “Hawaii, Then and Now.” Author William R. Castle grew up in Hawaii. “Not one of us knew when he had learned to swim any more than he could remember when he had learned to walk,” Castle wrote of his youth. “In those days, however, few learned to ride the surfboard. Some Hawaiians did it, and we thought they were wonderful, but there was a foolish tradition that only Hawaiians could master the art. We tried once or twice, fell off, and believed the tradition.”

### MORE ON OUR WEBSITE

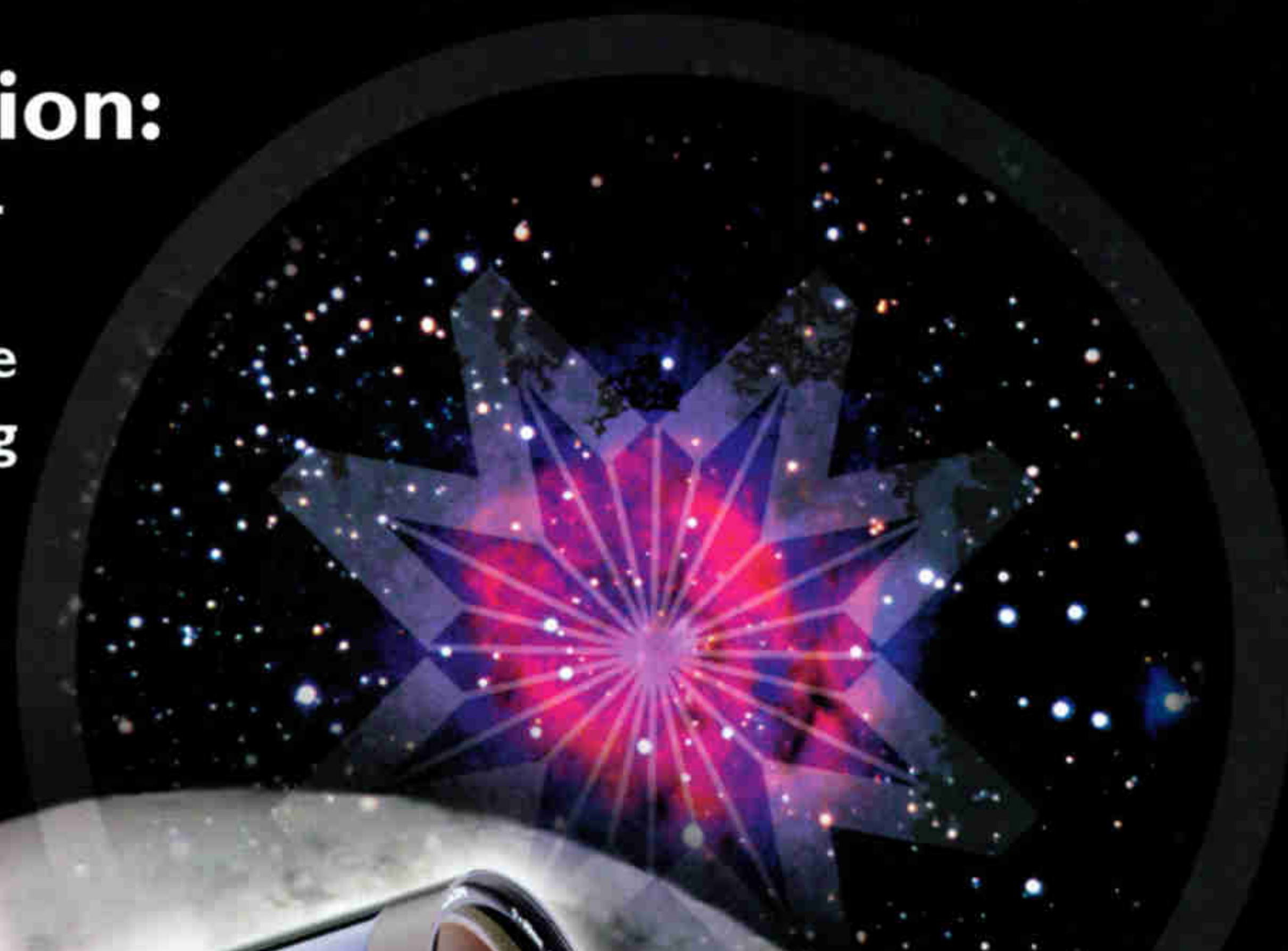
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— Sky & Telescope magazine



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# WILDLIFE AS CANON SEES IT

A Mediterranean monk seal swims near Cabo Blanco Peninsula, home to the largest extant colony of this rare and reclusive pinniped. Along this coastline peninsula in Western Sahara-Mauritania, about 110 monk seals inhabit large caves hidden below the shoreline cliffs. These sea caves provide secluded breeding sites, where each female gives birth to one black woolly pup; however, winter's oceanic storms bring huge swells and high tides, increasing pup mortality. Monk seals are especially sensitive to human intrusion, and protection of undisturbed

habitat is vital to the survival of this critically endangered species.

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#### Mediterranean Monk Seal (*Monachus monachus*)

**Size:** Length, average 240 cm

**Weight:** 250-300 kg

**Habitat:** Coastal areas of the Mediterranean Sea, Adriatic and Aegean Seas, Atlantic coast of northwest Africa and Madeira

**Surviving number:** Estimated at fewer than 500